



Michigan Department of Transportation

RESEARCH Administration

STATE PLANNING & RESEARCH PART II PROGRAM

FISCAL YEAR 2019

ANNUAL REPORT

OCTOBER 1, 2018 — SEPTEMBER 30, 2019



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STATE PLANNING AND RESEARCH, PART II, PROGRAM 2019 ANNUAL REPORT

Introduction

The Michigan Department of Transportation (MDOT) Statewide Planning and Research (SPR), Part II Program is authorized and funded through the Code of Federal Regulations, Title 23, Part 420, Subpart B. This program is administered through the Research Administration Section in the Bureau of Field Services and funds projects that have been initiated to address specific research needs at MDOT. SPR, Part II funding can be used to research and evaluate new technologies that relate to design, construction, maintenance and operation of all surface transportation modes. Other eligible uses include technology transfer and certain training activities.

Each year, MDOT develops a program consisting of 80 percent federally funded projects and 100 percent federally funded projects. The program also includes funding for various national research initiatives, such as the American Association of State Highway and Transportation Officials (AASHTO) Technical Service Programs (TSPs), Transportation Research Board (TRB), National Cooperative Highway Research Program (NCHRP), and University Transportation Centers (UTCs). The program must be reviewed and approved by the Federal Highway Administration (FHWA) Michigan Division Office prior to implementation. MDOT received FHWA approval on Aug. 16, 2018. This annual report covers the MDOT SPR Part II Program from Oct. 1, 2018, through Sept. 30, 2019.

Summary

Fiscal Year (FY) 2019 research was conducted in the following focus areas, representing several modes of transportation and MDOT's diverse business functions:

Program and Project Development

- Bridges and Structures
- Environment and Water Sources
- Rest Areas, Utilities and Landscaping
- Surveys and Automated Design

Planning and Finance

- Nonmotorized Planning and Development

Delivery and Operations

- Research Administration
- Construction
- Intelligent Transportation Systems (ITS)
- Maintenance
- Mobility, Systems and Signal Operations
- Transportation Safety

The FY 2019 SPR, Part II, Program consisted of 67 projects; 34 were 80 percent federally funded and 33 were 100 percent federally funded. The FY 2019 approved budget was \$6,466,409.31 and expenditures totaled \$4,735,262.64.

Tables 1 and 2 summarize 80 percent federally funded projects that were funded in FY 2019 while the associated progress reports contain project summaries with projects listed sequentially

by job number. Table 3 summarizes 100 percent federally funded projects. For additional information regarding a specific project, please contact Research Administration.

Program Milestones

Research Administration and its stakeholders achieved the following significant milestones in FY 2019:

- Received two AASHTO Research Advisory Committee (RAC) awards for high-value research projects. Attended the Summer RAC meeting, presenting posters on the following award-winning projects:
 - “Bridges Supplemental” award for *Development of Secondary Route Bridge Design Plan Guides*
 - “Safety Supplemental” award for *Sidepath Application Criteria Development for Bicycle Use*
- Attended the TRB Annual Meeting, presenting posters on the following high-value research projects:
 - “Sweet 16” award for *Wireless Data Collection Retrievals of Bridge Inspection*
 - “Safety Supplemental” award for *Evaluation of R1-6 Gateway Treatment Alternatives for Pedestrian Crossings*
- Began the FY 2021, 2022, and 2023 research program planning process:
 - During spring and summer 2019, MDOT developed new research priorities with input from focus area managers and administrators throughout the department. The priorities were shared with internal and external stakeholders.
 - In fall 2019, Research Administration requested the development of research ideas addressing MDOT’s priorities and all stakeholders were contacted.
 - Research Administration anticipates receiving new research ideas from its stakeholders by early December 2019.
- A new student assistant and research manager were hired to support the work of the Research Administration.
- Project managers led research advisory panels and held meetings to guide and manage the principle investigator’s research on 34 projects that were 80 percent federally funded.
- Completed 8 projects that were 80 percent federally funded, with current and previous years expenditures of approximately \$2.9 million, as summarized in Table 2.
- Initiated contracts for 12 new 80 percent federally funded projects in FY 2019, with total budgets equaling approximately \$3.4 million.
- Announced a young and new professional’s mentoring program through the research area in which recent MDOT employees are invited to participate in research advisory panels.
- Met with several Michigan universities and region management teams to discuss MDOT’s research program.
- Hosted three MDOT project manager training and appreciation events to encourage participation in the research program.
- Attended the AASHTO RAC Region 3 research peer exchange and ITS research peer exchange hosted by Iowa DOT and Texas DOT, respectively. Both events contributed to Research Administration’s knowledge of best practices for research programs.

- Developed new digital research report standards in compliance with Americans with Disabilities Act requirements.
- Provided input for AASHTO's report to the Federal Subcommittee on Research and Technology regarding transportation funding reauthorization.
- Published documents to transfer the results of research and innovation to practitioners, including the following Research Spotlights, highlighting the value of individual research projects.
 - Remote-controlled vessel provides safe and accurate inspection for bridge scour
 - 3-D models in MDOT highway projects save time and money, improve process
 - Pilot signal performance software improves driver travel times and traffic engineering efficiency
 - MDOT research develops generic ultra-high-performance concrete for mixing in the field
 - Improve asset management of reinforced concrete bridge decks with high-resolution imaging methods
 - Data Use Analysis and Processing (DUAP) system creates framework for sharing data throughout MDOT
 - Enhancing Michigan's traffic monitoring network with ITS sensors
 - Improving traffic data inputs for mechanistic-empirical pavement design software
- Research Administration prepared the FY 2020 SPR II program and received FHWA approval on Aug. 8, 2019.
- On Oct. 2, 2019 the first-ever Statewide Innovations Alignment Team (SIAT) Bright Idea Award was presented to Joe Rios for adding Graphic Information Systems (GIS) functionality to the construction permit system. SIAT developed the award to encourage and support creative innovative solutions.
- MDOT continues to partner with the Federal Highway Administration (FHWA) and together work toward innovating our transportation system through a State Transportation Innovation Council (STIC), the Every Day Counts Initiative (EDC), and the Accelerated Innovation Deployment (AID) Demonstration program. This year new website content was added to provide information about the successful partnership.

TABLE 1 - 80% FEDERALLY FUNDED

Job No.	FY 2019 Expenditures	Expenditures to Date	Total Budget	Project Manager	Agency	Principal Investigator	Title	Start Date	End Date	Page No.
128596	\$0.00	\$549,199.49	\$549,199.49	Guerrazzi, Sam	MTU	Colling	Bridge Design System Analysis and Modernization	11/1/2013	9/30/2019	13
128599	\$158,958.39	\$880,691.52	\$880,691.52	Chynoweth, Matt	LTU	Grace	Evaluating Long Term Capacity and Ductility of Carbon Fiber Reinforced Polymer Prestressing and Post-Tensioning Strands	10/1/2013	9/30/2019	15
128602	\$71,463.22	\$329,400.34	\$1,175,711.17	Chynoweth, Matt	LTU	Grace	Statewide Overall Carbon Fiber Composite Cable Bridge Monitoring	12/17/2013	9/30/2025	18
128607	\$0.00	\$2,615,388.81	\$3,050,024.81	Parker, Demetrius	U of M	Sayer	Connected Vehicle and Transportation Technology Research	10/1/2013	6/30/2020	20
129171	\$39,185.32	\$166,785.75	\$443,124.41	Hoffmeyer, Mary	CTC & Associates	Casey	Research Program Services	1/1/2016	9/30/2020	22
129832	\$169,957.12	\$329,281.82	\$329,281.82	Shaughnessy, Steve	MSU	Gates	Assessment of Countermeasure Gaps, Predictive Crash Analysis and Engineering Safety Programs in Michigan	6/1/2016	3/31/2019	23
131529	\$98,318.37	\$310,675.12	\$310,675.12	Burns, Eric	UM	Athanasopoulos-Zekkos	Asset Management of Retaining Walls	10/1/2016	11/30/2019	25
131585	\$567.83	\$253,563.11	\$253,563.11	Schenkel, Justin	MSU	Haider	Updated Analysis of Michigan Traffic Inputs for Pavement ME Design	10/1/2016	8/31/2018	26
131752	\$319,505.36	\$570,588.06	\$597,865.02	Skrocki, Chad	Ayres Associates	Schroeder	Applying Multi-Beam Sonar for Inspection for Bridge Scour and Performance of Bridge Scour Mitigation Methods	10/1/2016	5/31/2019	29
132225	\$0.00	\$183,385.67	\$183,385.67	Kahl, Steve	UM	El-Tawil	Commercial Production of Non-Proprietary Ultra High Performance Concrete	4/1/2017	12/31/2018	30
132227	\$156,158.81	\$188,400.41	\$284,741.92	Wagner, Bradley	WSU	Aktan	Best Practices for Modernizing MDOT Bridge Design Manual, Guides, and Policy Documentation	1/18/2018	12/31/2019	32
132228	\$71,603.49	\$151,037.67	\$166,705.69	Longworth, Melissa	MTU	Liu	Develop and Implement a Freeze Thaw Model Based Seasonal Load Restriction Decision Support Tool	4/1/2017	3/31/2020	33
132229	\$45,893.32	\$242,757.06	\$252,448.63	Adelman, Doug	AECOM	Klawon	Signal Performance Measures Pilot Implementation	11/1/2016	12/31/2018	34
132231	\$99,187.24	\$309,912.43	\$527,138.78	Alton, Nanette	MSU	Cregg	Slope Restoration on Urban Freeways	4/1/2017	4/30/2021	35
132232	\$50,847.39	\$190,824.46	\$204,616.47	Wilkerson, John	WSP	Mitchell	3D Highway Design Model Cost Benefit Analysis	7/1/2017	2/28/2019	37
200837	\$62,938.95	\$154,635.99	\$305,937.12	Jansson, Peter	WSU	Aktan	Bridge Structural Analyses for Staged Construction and Constructability Review	7/1/2017	4/1/2020	39
201393	\$185,890.15	\$194,338.51	\$407,272.79	Belcher, John	WMU	Attanayake	Effects of Concrete Cure Time on Epoxy Overlay and Sealant Performance	7/1/2018	12/31/2021	41

Job No.	FY 2019 Expenditures	Expenditures to Date	Total Budget	Project Manager	Agency	Principal Investigator	Title	Start Date	End Date	Page No.
201396	\$57,845.55	\$80,784.32	\$136,571.10	Burns, Eric	MSU	Corley-Lay	Accelerated Bridge Preservation Technologies	1/29/2018	1/29/2020	42
201399	\$41,919.92	\$42,048.81	\$212,704.74	Uzcategui, Alonso	MSU	Gates	Measure the Operational Cost and Benefit of Speed Feedback Signs	7/1/2018	6/30/2020	44
201402	\$60,550.63	\$68,918.52	\$169,010.19	Zweng, Harold	LTU	Bandara	Reduction of pH Levels from Underdrain Outlets	5/1/2018	12/31/2020	45
203301	\$25,000.00	\$50,000.00	\$50,000.00	Clover, Andre	TRB	N/A	Sponsorship of the TRB Roundtable on Preparing for Automated Vehicles and Shared Mobility Services	10/1/2017	9/30/2019	47
204643	\$77,837.12	\$77,837.12	\$315,425.84	Kopper, Kyle	WSU	Menkulasi	Evaluation of Camber and Deflections for Bridge Girders	3/1/2019	3/1/2021	48
204644	\$31,893.97	\$31,893.97	\$262,619.34	Bruinsma, Jonathan	WMU	Attanayake	Concrete Deterioration of Prestressed Bridge Beams	3/1/2019	2/28/2021	49
*204646	\$0.00	\$0.00	\$241,477.24	Bellgowan, Matthew	MSU	El-Gafy	Training Tools for Effective Advancement of Digital Technologies for Construction Field Operations	2/1/2020	4/30/2022	51
204647	\$25,047.40	\$25,047.40	\$104,917.82	Curtis, Beckie	MTU	Liu	Improved Calculation of Scour Potential in Cohesive Soils and Scour Susceptible Rock	5/1/2019	6/30/2020	52
204648	\$42,581.69	\$42,581.69	\$485,242.25	Gorman, Joe	Cambridge Systematics	Van Hecke	Development of a Network-level Evaluation Tool for Managing ITS Infrastructure	6/1/2019	6/30/2021	54
*204651	\$0.00	\$0.00	\$278,065.27	Feldpausch, Elise	Center for Automotive Research	Dziczek	Recruit and Maintain/Upgrade a High-Tech Workforce for Emerging Technologies	10/15/2019	6/30/2021	55
204652	\$28,415.75	\$28,415.75	\$124,660.03	Gaus, Jim & Longworth, Melissa	MSU	Zockaie	Effectiveness of Green Strobes on Winter Maintenance Vehicles and Equipment	6/4/2019	5/31/2020	56
204653	\$101,986.00	\$101,986.00	\$906,558.55	Cook, Steve	MTU	Brooks	Integration of Unmanned Aerial Systems Data Collection into Day-to-Day Usage for Transportation Infrastructure/Program Asset Management and Systems Operations	6/12/2019	6/11/2022	57
204654	\$9,878.06	\$9,878.06	\$213,401.91	McQuiston, Carissa	MSU	Gates	Synthesis of National Best Practices on Pedestrian and Bicycle Design, Guidance and Technology Innovations	4/1/2019	9/30/2020	58
204655	\$21,152.37	\$21,152.37	\$238,159.75	Bott, Mark	MSU	Savolainen	Evaluating the Impacts of the 2017 Legislative Mandated Speed Limit Increases	3/1/2019	2/28/2022	60
204656	\$20,211.91	\$20,211.91	\$196,494.10	Firman, Jason	MSU	Kassens-Noor	Performance and Safety of the US-23 Flex Route	3/1/2019	11/30/2022	62
204657	\$20,483.18	\$20,483.18	\$130,485.50	Bott, Mark	MSU	Savolainen	Effectiveness of Crash Fact/Safety Message Signs on Dynamic Message Signs	3/15/2019	4/15/2020	64
204658	\$90,688.42	\$90,688.42	\$162,504.32	Engle, John	WSP	Hill	Development of a Michigan Specific VISSIM Protocol for Submissions of VISSIM Modeling	11/27/2018	12/31/2019	66
	\$2,185,966.93	\$8,332,793.74	\$14,150,681.49	TOTAL 80% FEDERALLY FUNDED PROJECTS						

* Project start was delayed and research will begin during fiscal year 2020.

Note: Research project OR17-202, "3D Bridge Deterioration Models," that was included as a new project in FY 2018 and continuing for FY 2019 has been canceled and job number 204659 has been abandoned.

TABLE 2 - COMPLETED 80 PERCENT FEDERALLY FUNDED PROJECTS

PROJECT AREA	NUMBER OF PROJECTS	TOTAL PROJECT EXPENDITURES	TOTAL EXPENDITURES IN PERCENTAGE
Program & Project Development			
Bridges and Structures	4	\$2,183,864.74	73%
Environment & Water Sources	0	\$0.00	0%
Innovative Contracting	0	\$0.00	0%
Real Estate & Permits	0	\$0.00	0%
Rest Areas, Utilities, & Landscaping	0	\$0.00	0.0%
Surveys & Automated Design	1	\$190,824.46	6.4%
Work Force Development	0	\$0.00	0%
Subtotal	5	\$2,374,689.20	79%
Delivery & Operations			
Research Administration	0	\$0.00	0%
Construction	0	\$0.00	0%
Geotechnical & Foundation Design	0	\$0.00	0%
Intelligent Transportation Systems	1	\$50,000.00	2%
Fleet/Facility Management & Operations	0	\$0.00	0%
Maintenance	0	\$0.00	0%
Mobility, Systems, & Signal Operations	1	\$242,757.06	8%
Pavements & Materials	0	\$0.00	0%
Transportation Safety	1	\$329,281.82	11%
Worker/Facility Safety & Security Emergency Management	0	\$0.00	0%
Subtotal	3	\$622,038.88	21%
Multi-Modal Transportation			
Aviation	0	\$0.00	0%
Freight & Logistics	0	\$0.00	0%
Freight Rail	0	\$0.00	0%
Intercity Bus	0	\$0.00	0%
Local Transit	0	\$0.00	0%
Passenger Rail	0	\$0.00	0%
Private/For Hire Passenger Carriers	0	\$0.00	0%
Subtotal	0	\$0.00	0%
Planning & Finance			
Asset Management	0	\$0.00	0.00%
Contract Administration	0	\$0.00	0%
Finance	0	\$0.00	0%
Non-Motorized Planning & Development	0	\$0.00	0%
Program Development	0	\$0.00	0%
Transportation Policy	0	\$0.00	0%
Travel Demand Forecasting	0	\$0.00	0%
Subtotal	0	\$0.00	0%
TOTAL	8	\$2,996,728.08	100%

TABLE 3 - 100% FEDERALLY FUNDED PROJECTS

Project No.	Job No.	FY 2019 Expenditures	Expenditures to Date	Total Budget	Agency	Project Manager	Title	Start Date	End Date	Page No.
SPR1284(019)	131576	\$150,000.00	\$150,000.00	\$150,000.00	AASHTO/ FHWA	Clover, Andre	AASHTO Engineering Technical Service Programs	10/1/2018	9/30/2019	69
SPR1684(187)	132251	\$513,000.00	\$891,000.00	\$1,262,200.00	AASHTO	Burns, Dan	AASHTO 3.01 - Construction/Materials Module Enhancement/Implementation and Staff Training	10/1/2016	9/30/2020	70
TPF-5(176)		\$0.00	\$70,000.00	\$70,000.00	FHWA	Firman, Jason	Development of a Transportation Systems Simulation Manual (TSSM): First Edition	6/1/2016	9/30/2021	72
TPF-5(206)		\$50,000.00	\$450,000.00	\$450,000.00	Virginia DOT	Castle, Collin	Research, Development, and Deployment of System Operations Applications of Vehicle Infrastructure Integration (VII)	10/1/2008	6/30/2020	74
TPF-5(255)		\$20,000.00	\$80,000.00	\$80,000.00	FHWA	Shaughnessy, Stephen	Highway Safety Manual Implementation	11/9/2015	12/31/2020	76
TPF-5(267)		\$0.00	\$990,000.00	\$990,000.00	AL DOT	Bleech, Curtis	Accelerated Performance Testing for the NCAT Pavement Test Track	4/15/2015	3/31/2020	78
TPF-5(269)		\$0.00	\$60,000.00	\$60,000.00	Minnesota DOT	Krom, Ben	Development of an Improved Design Procedure for Unbonded Concrete Overlays	4/13/2012	4/30/2019	80
TPF-5(281)		\$30,000.00	\$80,000.00	\$110,000.00	Indiana DOT	Curtis, Beckie	Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE	10/1/2017	6/30/2021	83
TPF-5(290)		\$25,000.00	\$150,000.00	\$150,000.00	Iowa DOT	Perry, Gregory	Aurora Program	8/1/2014	10/31/2020	85
TPF-5(297)		\$17,500.00	\$105,000.00	\$105,000.00	OK DOT	Stallard, Tim	Improving Specifications to Resist Frost Damage in Modern Concrete Mixtures	1/10/2014	9/1/2019	88
TPF-5(305)		\$0.00	\$20,000.00	\$20,000.00	FHWA	Eacker, Michael	Regional and National Implementation and Coordination of Mechanistic-Empirical (ME) Design	10/1/2016	9/30/2019	91
TPF-5(313)		\$12,000.00	\$60,000.00	\$60,000.00	Iowa DOT	Staton, John	Technology Transfer Concrete Consortium	4/10/2015	12/31/2020	93
TPF-5(319)		\$25,000.00	\$125,000.00	\$125,000.00	FHWA	Peplinski, Suzette	Transportation Management Center (TMC) Pooled Fund Study	4/17/2015	4/16/2022	96
TPF-5(320)		\$25,000.00	\$125,000.00	\$150,000.00	IN DOT	Kennedy, Kevin	Base Funding for North Central Superpave Center	2/3/2015	9/30/2022	98

Project No.	Job No.	FY 2019 Expenditures	Expenditures to Date	Total Budget	Agency	Project Manager	Title	Start Date	End Date	Page No.
TPF-5(330)		\$0.00	\$40,000.00	\$40,000.00	Ohio DOT	Croze, Tim	No Boundaries Roadway Maintenance Practices	5/29/2015	6/30/2019	101
TPF-5(341)		\$0.00	\$450,000.00	\$450,000.00	Minnesota DOT	Bleech, Curtis	National Road Research Alliance	2/22/2016	2/22/2021	104
TPF-5(343)		\$0.00	\$100,000.00	\$200,000.00	Washington DOT	Torres, Carlos	Roadside Safety and Research for MASH Implementation	10/1/2016	12/31/2021	106
TPF-5(346)		\$20,000.00	\$80,000.00	\$80,000.00	Minnesota DOT	Urda, Steve (Interim)	Regional Roadside Turfgrass Performance Testing Program (Solicitation 1412)	3/25/2016	12/31/2019	109
TPF-5(347)		\$25,000.00	\$75,000.00	\$125,000.00	South Dakota DOT	Longworth, Melissa	Development of Maintenance Decision Support System	10/1/2016	9/30/2021	110
TPF-5(351)		\$0.00	\$60,000.00	\$60,000.00	Kansas DOT	Smalley, Erik	Self de-icing LED signals	3/25/2016	6/30/2021	113
TPF-5(353)		\$25,000.00	\$75,000.00	\$125,000.00	Minnesota DOT	Longworth, Melissa	Clear Roads Winter Highway Operations Pooled Fund	10/1/2016	12/31/2021	119
TPF-5(359)	200188 204724	\$35,000.00	\$115,000.00	\$115,000.00	MDOT	Feldpausch, Elise	Evaluating New Technologies for Roads Program Initiatives in Safety and Efficiency (ENTERPRISE) - Phase II	1/2/2018	11/30/2020	123
TPF-5(363)	201029	\$24,934.71	\$136,732.94	\$136,733.00	MDOT	Kahl, Steve	Evaluation of 0.7 inch Diameter Carbon Fiber Reinforced Polymer (CFRP) Pretensioning Strands in Prestressed Beams	12/5/2017	9/30/2020	125
TPF-5(368)		\$15,000.00	\$45,000.00	\$75,000.00	Iowa DOT	Staton, John	Performance Engineered Concrete Paving Mixtures	1/1/2017	12/31/2021	127
TPF-5(372)		\$20,000.00	\$40,000.00	\$100,000.00	Iowa DOT	Wagner, Brad	Building Information Modeling (BIM) for Bridges and Structures	11/8/2017	11/30/2022	129
TPF-5(375)		\$50,000.00	\$50,000.00	\$250,000.00	Minnesota DOT	Bleech, Curtis	National Partnership to Determine the Life Extending Benefit Curves of Pavement Techniques (MnROAD/NCAT Joint Study-Phase II)	1/1/2019	12/30/2023	131
TPF-5(379)		\$10,000.00	\$10,000.00	\$10,000.00	Iowa DOT	Leix, Tracie	Technology Exchange on Low Volume Road Design	10/1/2018	12/31/2020	133
*TPF-5(385)		\$0.00	\$0.00	\$135,000.00	Virginia DOT	Shapter, Paul	Pavement Structural Evaluation with Traffic Speed Deflection Devices (TSDD's)	3/1/2019	9/30/2021	135
*TPF-5(387)		\$0.00	\$0.00	\$75,000.00	Indiana DOT	Zakrzewski, Brian	Development of an Integrated Unmanned Aerial Systems (UAS) Validation Center	9/1/2018	12/1/2021	137

Project No.	Job No.	FY 2019 Expenditures	Expenditures to Date	Total Budget	Agency	Project Manager	Title	Start Date	End Date	Page No.
TPF-5(389)		\$0.00	\$100,000.00	\$100,000.00	Virginia DOT	Castle, Collin	Connected Vehicle Pooled Fund Study	10/1/2018	9/30/2021	139
TPF-5(396)		\$37,000.00	\$37,000.00	\$111,000.00	Wisconsin DOT	Karnes, Larry	Mid-America Freight Coalition (MAFC) Phase 3	2/1/2019	9/30/2021	140
TPF-5(397)		\$190,026.00	\$190,026.00	\$190,026.00	AASHTO/ FHWA	Clover, Andre	TRB Core Program Activities FFY 2019 (TRB FY 2020)	10/1/2018	9/30/2019	142
TPF-5(419)		\$1,229,835.00	\$1,229,835.00	\$1,200,000.00	FHWA	Clover, Andre	National Cooperative Highway Research Program (NCHRP) for FY 2019	10/1/2018	9/30/2019	143
		\$2,549,295.71	\$6,179,593.94	\$7,359,959.00	TOTAL 100% FEDERALLY FUNDED PROJECTS					

* Fiscal year 2019 contributions will be paid in FY 2020.

80% FEDERALLY FUNDED PROJECTS

Sequentially Listed by Job Number

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Bridge Design System Analysis and Modernization			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Sam Guerrazzi			
CONTRACT/AUTHORIZATION NO.	2013-0506	PROJECT START DATE	11/1/2013
PROJECT NO.	128596	COMPLETION DATE (Original)	11/30/2015
OR NO.	OR14-029	COMPLETION DATE (Revised)	9/30/2019
RESEARCH AGENCY	Michigan Technological University		
PRINCIPAL INVESTIGATOR	Tim Colling		
BUDGET STATUS			
FY 2019 Budget		Total Budget	
Vendor Budget FY 2019	\$0.00	Total Vendor Budget	\$549,199.49
MDOT Budget FY 2019	\$0.00	Total MDOT Budget	\$0.00
Vendor FY 2020 Expenditures	\$0.00	Total Budget	\$549,199.49
MDOT FY 2020 Expenditures	\$0.00	Total Expenditures	\$0.00
		Total Amount Available	\$0.00

PURPOSE AND SCOPE

MDOT currently designs between 50 and 80 bridges each year using an in-house software tool called the Bridge Design System (BDS). The initial software was developed over 30 years ago in the Fortran programming language and it has been updated and improved to adapt to MDOT's design process changes and American Association of State Highway Transportation Officials (AASHTO) standards. However, the evolutionary nature of desk top operating systems and accompanying programming languages has put MDOT's primary design tool at some risk. The bridge design calculations, procedures and methodology contained in the Bridge Design System must be documented and preserved, and the program must be modernized as needed to assure it will function on new operating systems and work integrally with third party programs. At the same time, existing bridge design calculations, processes, and procedures must be updated to meet AASHTO bridge design standards. The first steps in improving the software is an in-depth analysis of the existing system to better understand its function followed by an alternative analysis evaluating various improvements.

Tasks include:

- Reviewing and documenting the bridge design calculations, procedures, and methodology contained in the MDOT Bridge Design System.
- Performing a risk assessment of the current system.
- Providing recommendations to modernize the system incorporating new efficiencies and/or other programming improvements.
- Executing appropriate recommendations.
- Updating the user interface
- Modernizing the code
- Updating engineering calculations
- Developing new enhancements.

The following table shows SPRI II and Bridge Design funding and expenditures for this project:

Funding Source	FY 19 Expenditures	Total Expenditures	Total Budget
SPR II – JN 128596	\$0.00	\$549,199.49	\$549,199.49
Bridge Design	\$389,108.57	\$787,893.00	\$799,534.03

FISCAL YEAR 2014 ACCOMPLISHMENTS

The first year's proposed activities included reviewing and documenting the bridge design calculations, procedures, and methodology contained in the MDOT Bridge Design System. The reviewing and documentation activities progressed throughout the year such that draft documentation formats were presented.

FISCAL YEAR 2015 ACCOMPLISHMENTS

The project team finalized Interim Report's 1 and 2, taking into account all comments. Other tasks completed include instituting source control and an integrated test environment, building an automated test suite, splitting code into modules, removing common blocks, changing to "Free" source form, and eliminating proprietary extensions. Identifying recommended modifications to the BDS source code is 90 percent complete.

FISCAL YEAR 2016 ACCOMPLISHMENTS

The Final Research Report was completed and submitted. Version one of the modified BDS source code was submitted to MDOT.

FISCAL YEAR 2017 ACCOMPLISHMENTS

State Planning and Research funding for this project has been exhausted. Bridge design funded activities were realized in FY 2017. This fiscal year's accomplishments include:

- Beginning investigation into updating of the user interface
- Modernizing the code where possible
- Updated engineering calculations
- Began developing new enhancements.

FISCAL YEAR 2018 ACCOMPLISHMENTS

- Continued work on incorporating AASHTO updates
- Continued Modernizing the code as encountered
- Continued Updating engineering calculations
- Continued Development of new enhancements

FISCAL YEAR 2019 ACCOMPLISHMENTS

- Continue work on the AASHTO updates and testing.
- Work on incorporating the new Bulb T beam into the program.
- Continue development of new enhancements.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

On 06/30/2015, the project was extended to allow sufficient time to initiate software improvements identified during the course of the project. This was followed by a modification to the scope, cost, and duration as approved on 5/17/2016 where work was added to allow additional phases including updating the user interface, modernizing the code, updating engineering calculations, and developing new enhancements. This additional work was funded by non-SPR II funds. The budget and scope were also shifted on 09/19/2016 from a subcontractor to the prime contractor.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

The recommendation was to continue with AASHTO updates to make the software current and to continue with new enhancements to keep the software viable.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Evaluating Long Term Capacity and Ductility of Carbon Fiber Reinforced Polymer Prestressing and Post Tensioning Strands

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Matthew Chynoweth

CONTRACT/AUTHORIZATION NO.	2013-0065 Z2	PROJECT START DATE	10/1/2013
PROJECT NO.	128599	COMPLETION DATE (Original)	9/30/2016
OR NO.	OR14-024	COMPLETION DATE (Revised)	9/30/2019
RESEARCH AGENCY	Lawrence Technological University		
PRINCIPAL INVESTIGATOR	Nabil Grace		

BUDGET STATUS

FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$158,958.39	Total Vendor Budget	\$880,005.52
MDOT Budget FY 2019	\$4,810.00	Adjusted MDOT Budget	\$686.00
Vendor FY 2019 Expenditures	\$158,958.39	Total Budget	\$880,691.52
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$880,691.52
		Total Amount Available	\$0.00

PURPOSE AND SCOPE

Use of Carbon Fiber Reinforced Polymer (CFRP) as longitudinal prestressing and transverse post tensioning is a viable alternative to the 270 ksi low relaxation steel strands currently used by MDOT's prestressed and post tensioned bridge superstructures. CFRP strands are not subject to corrosion and have strength characteristics like steel. MDOT has used CFRP transverse post tensioning on two structures and has projects planned for CFRP longitudinal prestressing. This is a material MDOT will be using on future projects as well.

The current AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications do not contain guidance on the design of elements using CFRP prestressing or post tensioning. ACI 440.1R-09 provides guidance on the jacking and final stresses in CFRP strands to stay within a desired ductility range and provides guidance on the initial elastic losses of the CFRP fibers and resin. CFRP strands lack the ductility of steel strands and therefore, allowable maximum stress values are recommended to ensure ductile behavior of the overall structure, so the failure mode is like that of a steel strand structure.

ACI 440 discusses the creep rupture characteristics of CFRP strands but due to lack of good historical data, discussions of long-term losses due to creep, concrete shrinkage, and effects of environmental factors are very general. Bond fatigue, bond lengths for splices, susceptibility to fire damage, and other severe exposure conditions are also not addressed due to the lack of long-term testing data. Long term losses need to be considered during the initial design, as these values are subtracted from the ultimate capacity of the materials. AASHTO provides detailed methods and empirical equations for determining these losses in steel strands; however, no equivalent equations are available for CFRP strands. For current CFRP projects, detailed finite modeling has been performed to determine the performance of the materials. For CFRP strands to be used as a production design material, methodologies and empirical equations need to be developed to quantify these values and provide the designer with the guidance on how to properly apply these methodologies.

The long-term losses and other environmental effect will also need to be known for load ratings of structures with CFRP elements.

The scope of work includes a literature review, experimental investigation, field monitoring, analytical and numerical modeling, and the development of empirical equations and design criteria. A revision was made to the contract to include the overall design guidelines and specifications, with respect to flexural and shear design for concrete beams prestressed with CFRP strands. This research includes the design methodology in AASHTO LRFD format, specification development, and standard design template using the MathCAD software program.

FISCAL YEAR 2014 ACCOMPLISHMENTS

Performed laboratory testing for creep rupture, bond fatigue, bond splice length, development length, lap lengths, anchorage testing, long-term relaxation testing, and long-term losses and creep testing. Evaluation of worldwide design guidelines completed along with documentation of deficiencies when compared to AASHTO requirements.

FISCAL YEAR 2015 ACCOMPLISHMENTS

Continuation of creep rupture, bond fatigue, bond length, cold weather, fire chamber, and environmental testing occurred, along with dissemination of the results. As part of the analytical phase of the project, the Principal Investigator (PI) has proposed a modified prestressed flexural design methodology and a modified shear design methodology. The flexural methodology uses the concept of equivalent area of prestressing given the area of strand material. The PI assisted MDOT with the design of the Carbon

Fiber Composite Cables (CFCC) prestressed bulb-T M-86 over Prairie Creek bridge using this new methodology. The Research Advisory Panel also met with the PI twice during 2015 to observe laboratory testing and provide feedback on results to date.

FISCAL YEAR 2016 ACCOMPLISHMENTS

Continuation of all laboratory testing for creep rupture, bond fatigue, bond length cold weather effects, fire chamber effects, and environmental testing took place, along with load tests for several elements subject to the above testing. Work also advanced on the CFRP Prestressing Guidelines. Draft guidelines were submitted for MDOT review and comment, and two Research Advisory Panel meetings were held to review and provide guidance on additional activities.

During this time frame, MDOT also delivered a project in Southwest Region – M-86 over the Prairie Creek. This project consists of 104' long, 42" deep bulb-T beams, prestressed with CFRP strands. Final design calculations from MDOT were submitted to LTU for review, and a finite element model analysis was performed to validate the design. Once beam fabrication began, LTU assisted with QA, and troubleshooting of beam fabrication issues. Finite models were prepared based on actual prestress force per strand to determine acceptability of beams. All beams were determined to be acceptable.

Work also progressed on validation of design of the I-75 SB over Sexton Kilfoil Drain, which consists of 140' long, 60" deep bulb-T beams prestressed with CFRP strands. As part of the research project, LTU provided guidance on final design documents, along with providing a finite element model to validate the design.

These activities were done using the proposed design specification methodologies.

FISCAL YEAR 2017 ACCOMPLISHMENTS

In FY 2017, laboratory testing continued with a focus on the long-term behavior of the CFRP materials. It was decided that since LTU already has the material stressed in the load frames, we would continue to keep them loaded for another year to obtain more data points on long term strain and creep relationships.

MDOT let the materials procurement for the M-3 over I-94 bridge, of which LTU supported the design providing Finite Element Modeling of the design to ensure appropriate material proportions and stresses. MDOT will be performing the final design of Brush Street over I-94 as part of the overall I-94 advanced bridges for the I-94 modernization mega-project. As part of the research project, design validation and finite element model analyses will be prepared for this bridge as well.

The draft final guide specification was submitted for review, and comments were provided to the Principal Investigator. The MathCAD design template development progressed to the piloting stages as MDOT used a final version of the MathCAD design template on production designs.

Also, the I-75 SB over Sexton-Kilfoil drain bridge, at 140' long, is the longest CFCC prestressed bridge built to date. MDOT, in partnership with LTU, conducted a load test on this bridge once it was complete, and found the tested performance was equal to or better than the calculated performance.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Due to failure of a CFCC strand during the fabrication of the I-75 SB over Sexton Kilfoil beams, considerable effort was involved in the investigation as to the causes, and the effects on the beam. Also, as part of finalizing the research, the RAP decided to keep creep rupture specimens loaded for an additional amount of time and continue to collect data for as long as practicable.

A revised final report was submitted, and comments received. The final report and MathCAD design templates are expected to be delivered in early FY 2019. The MathCAD design templates have been used for the Brush Street over I-94 bridge, along with the preliminary designs of other bridges within the I-94 mega project corridor, and along M-39.

Dr. Grace also took part in reviewing, and providing comments on the NCHRP 12-97 effort, which is the national AASHTO LRFD Guide Specification for prestressing of concrete bridge elements using CFRP systems.

The RAP also took part in many discussions regarding a refined shear design, and witnessed many laboratory experiments, including loading of full-sized beam specimens to failure. Also, Dr. Grace and a RAP member traveled to Japan in early November to witness material testing, and work on advances in the technology with one of the material manufacturers.

The research team is in contact with MDOT Engineers to update them with the test results and the progress of the finite element study. A recent visit by MDOT Engineers and Engineers from other States took place on Sept. 13, 2018. Research progress was discussed with MDOT Engineers

Identification of additional CFCC prestressed beam bridges continues, in accordance with specific selection criteria.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The research team finalized the final report and other deliverables including MDOT design guide for CFRP prestressed beams in AASHTO LRFD format and design examples. The documents were submitted to MDOT 90 day prior to the end date of the project.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Changes to cost, duration, and scope were approved 2/4/2014 to develop CFRP specifications in AASHTO LRFD format for the design of elements prestressed with CFRP. An additional cost, duration, and scope change was approved 9/22/2016 to allow additional work to include finite element analysis and MathCAD services for the deployment of three carbon fiber structures. Finally, a no cost time extension for one year was done to allow time for building a new test frame and for additional carbon fiber strands to be stress rupture tested.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

The final research deliverables, in terms of the research report, design guidelines in AASHTO LRFD format, and MathCAD design templates have been submitted to MDOT. MDOT has used the deliverables on bridges within the I-94 modernization project, both designed by in-house and consultant forces.

Earlier this year, Lawrence Technological University facilitated a training session to an audience of MDOT and consultant bridge designers on the highlights of the design guidelines and walked the group through a detailed design example. This workshop was very well-attended.

MDOT has also taken part in facilitating webinars with TRB, and the American Composite Manufacturers Association, to educate transportation agencies, material suppliers and contractors on the use of composite materials.

From an implementation perspective, the design guidelines are fully implemented, and MDOT reviews replacement types of projects for CFRP prestressed superstructure bridge candidates.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Statewide Overall Carbon Fiber Composite Cable Bridge Monitoring			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Matthew Chynoweth			
CONTRACT/AUTHORIZATION NO.	2014-0043	PROJECT START DATE	12/17/2013
PROJECT NO.	128602	COMPLETION DATE (Original)	9/30/2020
OR NO.	OR14-039	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Lawrence Technological University		
PRINCIPAL INVESTIGATOR	Nabil Grace		
BUDGET STATUS			
FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$135,221.46	Total Vendor Budget	\$1,166,711.17
MDOT Budget FY 2019	\$8,000.00	Adjusted MDOT Budget	\$9,000.00
Vendor FY 2019 Expenditures	\$71,463.22	Total Budget	\$1,175,711.17
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$329,400.34
		Total Amount Available	\$846,310.83
PURPOSE AND SCOPE			
Carbon Fiber Composite Cable (CFCC), and other Carbon Fiber Reinforced Polymer (CFRP) materials are being used for prestressing applications in Michigan bridge rehabilitation and replacement projects. As this is still considered an innovative material, understanding and quantification of the long-term behavior based on stress/strain gage readings of previous field deployments is essential for future design and construction considerations. Continued monitoring of the CFCC elements in already constructed bridges will provide information on the long-term behavior and allow for recommendations to be made for future designs, taking into account the behavior of current field deployments.			
FISCAL YEAR 2014 ACCOMPLISHMENTS			
Completed the setup of the monitoring website and data are now available for review and download. The research team at Lawrence Technological University (LTU) was successful at downloading data from the website and recordings from Bridge Street bridge, M-50 bridge, and M-39 bridge have been checked. Readings from M-50 and M-39 bridges had minor issues that were corrected later. The system was then working properly in both bridges and the readings conformed to the theoretical calculations. At the close of the Fiscal Year (FY), work was continuing on connecting M-102 bridge to the website and making the data available. As part of the nearly completed construction project, a power system is to be installed on-site. Scheduled maintenance visits to Bridge Street bridge and M-50 bridge were postponed until the necessary power system for M-102 is available.			
FISCAL YEAR 2015 ACCOMPLISHMENTS			
Data from each bridge has been used for a separate research project, 2013-0065 - Evaluating Long Term Capacity and Ductility of Carbon Fiber Reinforced Polymer prestressing and post tensioning strands. There have been pieces of data collection equipment and sensors that have been noted as not functioning properly, and a meeting with the supplier will take place in early 2016. In the meantime, data received is being used to corroborate analytical calculations and responses.			
FISCAL YEAR 2016 ACCOMPLISHMENTS			
Monitoring of bridges containing CFRP elements continued throughout FY 2016. Several locations had equipment upgrades, along with assessments of the adequacy of the data collection equipment. Reports were provided of the trends in strains, loads, and deflections at different locations, and the data has been continued to be used in conjunction of research project 2013-0065 - Evaluating Long Term Capacity and Ductility of Carbon Fiber Reinforced Polymer prestressing and post tensioning strands. The data analysis and trends from this monitoring continue to validate numerical simulation of bridge behavior being done as part of that research.			
FISCAL YEAR 2017 ACCOMPLISHMENTS			
Monitoring of the current inventory of bridges will continue. The I-75 SB over Sexton Kilfoil Drain construction is complete and load test was performed. This bridge was added to the overall monitoring contract, and monitoring activities will continue until project completion in 2020.			

FISCAL YEAR 2018 ACCOMPLISHMENTS

Continued monitoring, and regular data reporting on all six (6) wired bridges will keep correlating actual experimental data with theoretical calculated values.

Reporting of data to the Research Advisory Panel (RAP) was done with meetings for the OR14-024 project, and this data was used to calibrate several equations and constants used in the proposed guide specifications.

The subcontractor visited the M-50 and Bridge Street bridges for annual maintenance. Defective equipment was noted, which resulted in abnormal readings. The subcontractor was able to replace the defective hardware and bring the system back to functioning properly. The Bridge Street bridge is also suffering from possible defective hardware but the troubleshooting and repair of the system is beyond the scope of annual maintenance.

In addition, the wireless carrier has issued a firmware upgrade to their phones as a fix from universal hacking and introducing malware into these systems. This fix can be done remotely on newer phones. Older phones such as those supplied in the bridge monitoring systems need to be upgraded manually. While the subcontractor was able to upgrade the firmware manually on the phones, the wireless carrier will stop supporting 3G networks in the next year and all phones will require the ability to utilize a 4G network. Therefore, an estimate for the repair of the hardware at Bridge Street and an upgrade for the phones in all bridge locations has been submitted to MDOT for review and approval of this amendment. This work will most likely take place in spring of 2019.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Monitoring continues for the M-39, M-50, M-102, Bridge Street and I-75 bridges. The research team at LTU was successful at downloading data from all bridges with some concerns in the Bridge Street Bridge. The subcontractor visited all bridge sites, checked hardware as well as the accuracy of the collected data, and provided a report on the conditions of all bridge monitoring systems. The systems on M-50, M-102, and I-75 bridges were all in good working condition and provided accurate readings. There were some sensors on M-39 bridge that were not giving accurate readings (even when collected manually) and they were assumed defective. In Bridge Street Bridge, it appears that a recent power surge caused some hardware issues and also caused some sensors to stop reading properly. Defective sensors were removed from the site and a plan to address the conditions of the monitoring system of Bridge Street Bridge is currently underway and being discussed with MDOT Engineers.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Continued monitoring of the bridges in the contract, and analysis of long-term material behavior is expected. This analysis will be used to adjust material resistance factors and long-term durability considerations in the current design guidelines that MDOT has implemented as part of a separate research project.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

One contract revision was approved on 8/8/2017 to add to the scope and increase the budget due to the addition of the I-75 Southbound bridge over the Sexton-Kilfoil Drain, the longest CFCC prestressed bridge built to date. Another revision was approved on 3/5/2019 for a budget increase and extension to allow for unexpected repairs of monitoring systems as well as to continue monitoring for an additional five years.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Expected project completion in fiscal year 2025.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Connected/Automated Vehicle and Infrastructure Research			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (<i>PLEASE EXPLAIN</i>)			
PROJECT MANAGER: Demetrius Parker			
CONTRACT/AUTHORIZATION NO.	2014-0006	PROJECT START DATE	10/1/2013
PROJECT NO.	128607	COMPLETION DATE (Original)	9/30/2015
OR NO.	OR14-053	COMPLETION DATE (Revised)	06/30/2020
RESEARCH AGENCY	University of Michigan		
PRINCIPAL INVESTIGATOR	James Sayer		
BUDGET STATUS			
FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$384,636.00	Total Vendor Budget	\$3,000,000.00
MDOT Budget FY 2019	\$25,000.00	Adjusted MDOT Budget	\$50,024.81
Vendor FY 2019 Expenditures	\$0.00	Total Budget	\$3,050,024.81
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$2,615,388.81
		Total Amount Available	\$434,636.00
PURPOSE AND SCOPE			
<p>To construct a research test bed to investigate and evaluate technologies related to the interfacing of roadway infrastructure (including smart and connected technologies) and roadway vehicles (connected and automated vehicles). The safe operation of connected and automated vehicles requires technological advances in roadway infrastructure including, but not limited to, roadside communication equipment for connected vehicles, road weather information system (RWIS) technologies, Intelligent Transportation System (ITS) infrastructure, pavement delineation devices (reflectors, pavement markings, freeway lighting), sign supports, signs (dynamic and static) and intersection treatments (traffic signals, pedestrian signals/signing). Knowledge gained from research performed at this newly constructed UM Mobility Transformation Facility (Test Track) will help MDOT improve safety, mobility and efficiency of the public roadway system by accommodating and implementing connected and automated vehicle technologies.</p>			
FISCAL YEAR 2014 ACCOMPLISHMENTS			
<p>A construction project was awarded to Angelo Lafrate Construction Company. The anticipated completion of construction is on November 14, 2014.</p> <p>Progress- To- Date:</p> <ul style="list-style-type: none"> • UMTRI tours of the construction site were performed on September 10-12 for the 21st ITS World Congress held in Detroit, Michigan. • Detention Ponds 100% complete. • 95% completion of the storm sewer installations. • Approximately 95% completion of the mass earthwork balancing. • Began installation of the MSE wall along the creek on the south end of the job site. • Began electrical power supply installation with DTE coordination. <p>Project payments are based on Milestones.</p> <p>Since no milestone was 100 percent complete by September 30, 2014, no payments were made during Fiscal Year (FY) 2014.</p>			
FISCAL YEAR 2015 ACCOMPLISHMENTS			
<ul style="list-style-type: none"> • On July 20, 2015, UM/UMTRI held a very successful Open House at the newly constructed M-City/Test Track. The facility was open to the public during the evening hours the week of July 20th. • Completed both Milestones # 2 and #3 [Parts B & C respectively]. • Both Milestones #4 and # 5 were near completion as of September 30, 2015. • Design consultant will prepare a set of as-constructed plans for delivery to MDOT by first quarter of FY 2016 [Oct/Nov. 2015]. 			
FISCAL YEAR 2016 ACCOMPLISHMENTS			
<ul style="list-style-type: none"> • Completed Milestone 5 with the turn in of an MDOT approved set of as-constructed plans. • Completed traffic signal installations on April 21, 2016 [Milestone 4 task]. • Majority of fiber optics installation completed by FYE [Milestone 4 task]. • Traffic Control Lab installation completion is anticipated for 01/31/17 [Milestone 4 task]. • Dedicated Short Range Communication (DSRC) infrastructure installations (v3.2) partially completed by 9/30/16. Remainder of the installations planned completion by 12/31/16 [Milestone 4 task]. • Held initial meeting with UM MTC/UMTRI directors and MDOT technical experts to discuss MDOT's research interest along with the analyses, evaluations, and testing to occur under Milestone 6. 			

- Start development of the Milestone 6 work plan. The Principal Investigator (PI) was out for a while near the end of the fiscal year so this is still under development.

FISCAL YEAR 2017 ACCOMPLISHMENTS

- Various project team discussion meetings [via conference call] were held throughout the fiscal year. Two (2) face-to-face meetings were held with the PI and MDOT project team. A revised draft Milestone 6 work plan was completed. PI to submit a final work plan sometime during 1st quarter of FY 2018.
- Completed fiber optics installation.
- Completed Traffic Control Lab installation.
- Completed remainder of the DSRC infrastructure installations.
- Acquired Lidar sensor (Quanergy M8) and developed software modules to record raw distance and intensity data.
- Acquired Mobileye unit and developed software modules to record raw Mobileye messages derived from the unit.
- Mounted Mobileye unit and Lidar sensor onto a midsize sedan and optimized the sensor positions.
- Developed software to (1) convert raw Lidar data to 3D coordinates and intensity readings, and (2) convert raw Mobileye messages into lane detection reliability index, lane geometry information, and lane marking width measurements.
- Implemented a module visualizing the converted Lidar data and Mobileye data in real time.
- Recorded preliminary driving test data from Lidar and Mobileye units while they were mounted on car.

FISCAL YEAR 2018 ACCOMPLISHMENTS

- Acquired and mounted a Global Positioning System (GPS) and high-fidelity camera.
- Began integrating developed modules into a single program for efficient data collection and easy data management. (90 percent complete)
- Started synchronizing heterogeneous data from multiple sensors based on GPS time. (90 percent complete)
- Tested software program's reliability. Runs to collect preliminary data on the test sections were performed.
- Began collecting lane marking data for different materials on US-23. (Data collection approximately 40 percent complete.)
- Worked on developing a post-processing software system to extract data from recorded raw files and analyze them. (80 percent complete)
- Pavement markings were also installed on US-23 for study.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Hardware Update: 90% Complete.
 Software Update: 100% Complete.
 Data Collection: 90% Complete.
 Data Analysis: 80% Complete.

Researcher continues to work on measuring the lane marking materials using a Retro-reflectometer on the US-23 Flex Route. Quantitative analysis on the measured retroreflect data collected also continues. Researcher plans to develop figures of merit (score) of the four (4) types of lane marking's reflectivity under study along the test sections on US-23.

Planning and development of the project final report began. This report shall include an evaluation of the operational effectiveness of various smart technologies, key lessons learned related to the deployment of smart highway technologies, integration of roadway infrastructure needed for Connected/Automated (C/A) vehicles, and testing methods needed for infrastructure supporting C/A vehicles.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

There was a change in principal investigator approved by MDOT in 2017. MDOT also approved a shift in the budget to change Milestone 6 to span over a 2-year period [2018 and 2019]. This milestone scope was changed to extend the research outside of the MCity test track to include real-world off-site locations for further testing along the US-23 Flex Route corridor, and possible City of Ann Arbor routes.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion in fiscal year 2020.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Research Program Services			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Mary Hoffmeyer			
CONTRACT/AUTHORIZATION NO.	2016-0060	PROJECT START DATE	1/1/2016
PROJECT NO.	129171	COMPLETION DATE (Original)	9/30/2019
OR NO.	OR15-001	COMPLETION DATE (Revised)	9/30/2020
RESEARCH AGENCY	CTC and Associates LLC		
PRINCIPAL INVESTIGATOR	Patrick Casey		
BUDGET STATUS			
FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$110,781.11	Total Vendor Budget	\$443,124.41
MDOT Budget FY 2019	\$0.00	Adjusted MDOT Budget	\$0.00
Vendor FY 2019 Expenditures	\$39,185.32	Total Budget	\$443,124.41
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$166,785.75
		Total Amount Available	\$276,338.66
PURPOSE AND SCOPE			
MDOT is striving to deliver innovative research results publicly. If effective communication is not provided, research results can end up sitting on a shelf with no one using the outcomes to improve operations. This project addresses this problem by transferring the outcomes from the research project report to the Department and public in clear and simplified documents. CTC will also work with Research Administration to continue to improve operations.			
FISCAL YEAR 2016 ACCOMPLISHMENTS			
Completion of several spotlights. Innovation Snapshot Folios, including new design template and product logo featuring four articles drafted, were edited and laid out. September and October snapshots were completed. Research Update Newsletter was done by September 30 th . Environmental Services Section PowerPoints were also done along with some report Editing.			
FISCAL YEAR 2017 ACCOMPLISHMENTS			
Completion of additional Spotlights, December Innovation Snapshot, Newsletters, report editing, and other services as needed.			
FISCAL YEAR 2018 ACCOMPLISHMENTS			
Completion of additional Spotlights as well as assisting with technology transfer of accomplishments through social media guidance and other services as needed.			
FISCAL YEAR 2019 ACCOMPLISHMENTS			
Completed additional Spotlights and the At-A-Glance report summary of funding statistics and project progress for fiscal year 2018. Assisted with social media, and Transportation-related library promotion of research reports. Implemented use of templates and guidance for Americans with Disabilities Act (ADA) compliance for spotlight documents.			
FISCAL YEAR 2020 PROPOSED ACTIVITIES			
Expect completion of additional Spotlight newsletters, production of new Video Spotlights and development of a distribution strategy. CTC will assist with other services as needed.			
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))			
This contract was revised 6/28/2019 to extend the project end date one year to provide the vendor with additional time to prepare and provide all requested deliverables. There was also a change in the MDOT Project Manager due to staff changes.			
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)			
Project expected completion in FY 2020.			

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Assessment of Countermeasure Gaps, Predictive Crash Analysis and Engineering Safety Programs in Michigan

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Steve Shaughnessy

CONTRACT/AUTHORIZATION NO.	2013-0066 Z7	PROJECT START DATE	6/1/2016
PROJECT NO.	129832	COMPLETION DATE (Original)	3/31/2017
OR NO.	OR15-194	COMPLETION DATE (Revised)	5/31/2019
RESEARCH AGENCY	Michigan State University		
PRINCIPAL INVESTIGATOR	Timothy Gates		

BUDGET STATUS

FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$169,957.12	Total Vendor Budget	\$328,349.00
MDOT Budget FY 2019	\$500.00	Adjusted MDOT Budget	\$932.82
Vendor FY 2019 Expenditures	\$169,957.12	Total Budget	\$329,281.82
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$329,281.82
		Total Amount Available	\$0.00

PURPOSE AND SCOPE

Michigan has seen a 36% decline in fatalities since 1995. In 2010, the Michigan Department of Transportation (MDOT) adopted Toward Zero Deaths (TZD) as a strategic area of focus for safety. This project looks into improvements that could be made in Michigan to continue and accelerate past successes and move TZD forward.

The scope includes the following:

1. Literature review.
2. Review the engineering portions of the TZD National Strategy.
3. Utilize national crash databases to determine states that have made recent progress in reducing fatal crashes.
4. Review and synthesize "Zero Goal" strategies developed by state agencies nationally.
5. Conduct State DOT interviews regarding TZD strategies and safety program processes.
6. Conduct local agency interviews regarding TZD strategies and safety program processes.
7. Determine highly effective engineering treatments not currently used in Michigan.
8. Review the current Michigan local agency call for projects process.
9. Conduct interviews on the current MDOT trunkline and local agency safety calls for projects.
10. Develop a gap analysis and recommend safety strategies that can be further deployed.
11. Separate and classify crashes by severity, frequency, and jurisdiction including trunkline/local, rural/urban, and others.
12. Utilize gap analysis and crash data to predict the safety impacts of implementing strategies.
13. Provide recommendations to the trunkline and local agency safety calls for projects processes.
14. Develop a tool and user guide for MDOT, local agencies, and consultants to prioritize safety countermeasures.
15. Recommend changes to and refine the current Time of Return (TOR) form
16. Conduct training workshops on TZD, gap analysis and crash impacts, and new/revised tools
17. Review Literature on Transportation Systems Management and Operations (TSMO) Conversions within State DOTs
18. Contact Select State DOTs that have Converted to TSMO or are Considering TSMO Conversion
19. Analyze the Relationships between State Safety Funding Levels and Fatal Crash Rates
20. Estimate Necessary Safety Funding Level to Reach Statewide Safety Goals Identified in Strategic Highway Safety Plan (SHSP)
21. Prepare TSMO Report and Other Deliverables
22. Develop and deliver draft and final reports.

FISCAL YEAR 2016 ACCOMPLISHMENTS

1. Began the literature review. State and federal TZD content is being reviewed to determine best practices. General highway safety literature is also being reviewed. This task is ongoing and expected to be completed by the end of the first quarter in FY 2017.
2. Review and synthesis of engineering portions of the National TZD Strategy is underway based on materials obtained in Task 1. This task is ongoing and expected to be completed by the end of the first quarter in FY 2017.
3. Review and synthesis of "Zero Goal" strategies developed by state agencies is also underway based on materials obtained in Task 1. This task is ongoing and expected to be completed by the end of the first quarter in FY 2017.
4. Identification of states utilizing best practices for TZD has been initiated. This work is ongoing and will be completed in the second quarter of FY 2017.

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5. Began identifying and contacting local agencies to conduct interviews Regarding TZD and Safety Program Processes. An email was developed to initiate contact with select local agencies and the team has been working through Pam Blazo at MDOT to identify which agencies to contact. Several local agencies have agreed to participate, and these interviews are expected to wrap up in the second quarter of FY 2017.
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FISCAL YEAR 2017 ACCOMPLISHMENTS

1. Completed literature review in the first quarter of 2017.
 2. Completed review and synthesis of engineering TZD strategies this year.
 3. Completed review and synthesis of state Zero Goal strategies in the second quarter of 2017.
 4. Identified states for state agency interviews utilizing best practices for TZD based on Fatality Analysis Reporting System (FARS) trends and other relevant information. Agencies have been contacted and interviews that began in July have been completed. This includes discussions with the following state DOTs: California, Oregon, Washington, Ohio, Minnesota, Wisconsin, Montana, and Iowa. A writeup of both in-state and out-of-state DOT interviews has been completed.
 5. Local agency interviews were completed.
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FISCAL YEAR 2018 ACCOMPLISHMENTS

1. Completed state agency interviews with MDOT and local agency personnel about the Call for Projects process.
 2. Finished out of state interviews to develop the gap analysis.
 3. Completed training for local agencies and MDOT personnel on the Call for Safety process in July.
 4. Reformatted the TOR form to make it more streamlined.
 5. Completed a comprehensive Gap Analysis to determine where improvements to the MDOT and Local Agency Call for Projects process can be improved.
 6. Provided recommendations to improve the Call for Projects process for MDOT and local agencies.
 7. Developed a streamlined low-cost systemic project selection tool and guide for local agency use.
 8. Interviewed various states DOTs about implementation and/or management structure conversion to a TSMO focused organization.
 9. Reviewed various literature on TSMO conversions.
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FISCAL YEAR 2019 ACCOMPLISHMENTS

Final reports on both Safety and TSMO were delivered and approved on July 29th, 2019.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The completion date for this project was extended on 5/23/2017, due to delays in contract negotiations and the research project schedule. Additional scope and budget (\$40,000) were added on 2/5/18 so investigation into the feasibility and impacts associated with changing to a Transportation Systems Management and Operations (TSMO) strategy for MDOT could be included. There was a further extension to 2/28/2019 to present findings of the research to MDOT staff, and to 5/31/2019 to complete the TSMO report and other deliverables.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

The research resulted in improvement recommendations for MDOT's engineering safety programs' procedures and countermeasures. Recommendations under consideration for implementation include:

- Hot spot versus systematic projects to ensure funds are distributed to support Michigan's SHSP goals.
 - Investigating creating a TZD/SHSP coordinator to assist with training local agencies.
 - Encouraging Michigan's Streamlined Systematic Safety Program to promote Highway Safety Improvement Program (HSIP) applications from local agencies
 - Develop additional data driven HSIP funding decision making analytical tools.
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**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Asset Management of Retaining Walls			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Eric Burns			
CONTRACT/AUTHORIZATION NO.	2016-0068 Z2	PROJECT START DATE	10/1/2016
PROJECT NO.	131529	COMPLETION DATE (Original)	7/31/2018
OR NO.	OR15-114	COMPLETION DATE (Revised)	11/30/2019
RESEARCH AGENCY	University of Michigan		
PRINCIPAL INVESTIGATOR	Adda Athanasopoulos-Zekkos		
BUDGET STATUS			
FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$98,318.37	Total Vendor Budget	\$310,675.12
MDOT Budget FY 2019	\$15,000.00	Total MDOT Budget	\$0.00
Vendor FY 2019 Expenditures	\$98,318.37	Total Budget	\$310,675.12
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$310,675.12
		Total Amount Available	\$0.00
PURPOSE AND SCOPE			
<p>The Michigan Department of Transportation (MDOT) is beginning to inspect and inventory Earth Retaining Structures. This project reviews damaged and sound retaining walls in Michigan and inspection procedures in other states to develop cost effective procedures for assessing and monitoring retaining walls. Research tasks include developing possible mitigating procedures for repairs, testing wall monitoring equipment, developing wall inspection methods, creating an asset management plan for incorporation into MiBRIDGE, documenting retaining wall elements for a manual, and conducting training for inspectors.</p>			
FISCAL YEAR 2017 ACCOMPLISHMENTS			
Completed initial field review of retaining walls and submitted draft retaining wall field inspection form.			
FISCAL YEAR 2018 ACCOMPLISHMENTS			
Developed draft retaining wall inspection form and inspection guidelines. Selected and procured retaining wall sensors. Installed retaining wall sensors and instrumentation at I-696 Eastbound retaining wall location. Began collecting data at this location.			
FISCAL YEAR 2019 ACCOMPLISHMENTS			
Installed retaining wall sensors at the M-10 (Lodge Freeway) retaining wall location and begin collecting and analyzing data. Continued to collect and analyze data for I-696 Eastbound retaining wall location. Continued work on retaining wall inspection form, inspections guidelines, and the final research report.			
FISCAL YEAR 2020 PROPOSED ACTIVITIES			
Completion and submission of the project final report is expected, along with a presentation to the Research Panel and MDOT Bridge and Geotechnical staff.			
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))			
<p>There was a reallocation in the budget to shift funds from student tuition and fees for a graduate student to instead support post-doctoral researcher Dr. Athena Gkrizi, which resulted in a very small budget decrease approved on 2/3/2017. A project extension to 12/31/2018 allowing for better data collection was approved 6/19/2018, another extension to 5/31/2019 was approved on 11/14/2018 to allow for better data collection over the winter and spring of 2019, and a final extension to 11/30/2019 was approved on 9/6/2019 to provide additional time for data analysis and completion of the final report.</p>			
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)			
Project expected completion in FY 2020.			

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Updated Analysis of Michigan Traffic Inputs for Pavement ME Design			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Justin Schenkel			
CONTRACT/AUTHORIZATION NO.	2013-0066 Z8	PROJECT START DATE	10/1/2016
PROJECT NO.	131585	COMPLETION DATE (Original)	8/31/2018
OR NO.	OR15-154	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University		
PRINCIPAL INVESTIGATOR	Syed Haider		

BUDGET STATUS			
FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$0.00	Total Vendor Budget	\$224,705.00
MDOT Budget FY 2019	\$0.00	Total MDOT Budget	\$28,858.11
Vendor FY 2019 Expenditures	\$0.00	Total Budget	\$253,563.11
MDOT FY 2019 Expenditures	\$567.83	Total Expenditures	\$253,563.11
		Total Amount Available	\$0.00

PURPOSE AND SCOPE

In 2009, a research project, "Characterization of Truck Traffic in Michigan for the New Mechanistic Empirical Pavement Design Guide," was completed that analyzed permanent traffic recorder data in Michigan to prepare inputs for the mechanistic-empirical (ME) pavement design method. This project resulted in the availability of statewide averages and cluster averages for the major traffic inputs. However, this was based on traffic data from 2005 and 2006. Since then additional sites have been added and some sites have been moved or downgraded. The analysis should be re-evaluated and recreated with the latest traffic data, including all the current permanent traffic recorder locations, and attempt to create a methodology that allows MDOT to create clusters and evaluations of future traffic data so that new research projects will become less frequent. This will very likely impact the existing traffic cluster methodology and characteristics of those clusters.

Accordingly, this may impact the PrepME software as developed per the Transportation Pooled-Fund Study: TPF-5(242), "Traffic and Data Preparation for AASHTO Pavement-ME Analysis and Design." This software is capable of pre-processing, importing, checking the quality of raw Weigh-In-Motion (WIM) traffic data, and generating three levels of traffic data inputs with built-in clustering analysis methods for Pavement ME Design. One of those built-in traffic clustering types is the MI cluster method from the 2009 research project. If results of this research project impact the cluster method, then changes to the PrepME software should be identified and potentially corrected.

The following are the specific objectives of the study:

1. Evaluate other states' experiences with developing ME traffic inputs and traffic clustering methodologies, as well as recommendations from the new Traffic Monitoring Guide (TMG) and the LTPP Pavement Loading User Guide.
2. Compare the original cluster analysis methodology to other methodologies and/or literature from objective 1 and determine which methodology is best suited for MDOT use. Alternatives include the original 2009 cluster methodology, revised version of the 2009 cluster methodology, one of the methodologies from objective 1, or a new methodology altogether. From these alternatives, provide a recommendation for MDOT use.
3. If the 2009 cluster methodology is not recommended or it needs modifications, then document the recommendations or changes to the cluster methodology and develop a tool or procedure for MDOT to evaluate and create the clusters for the specific traffic inputs to update traffic clusters in the future. This tool or procedure should lessen the need for future research and reduce demand for MDOT resources.
4. Establish new and/or updated traffic clusters, descriptions, equations, and associated inputs.
5. Review the PrepME operation and Michigan cluster output. Identify possible errors or changes required for the PrepME because of this research. Document findings and recommendations for PrepME enhancements.
6. Develop a research report documenting findings, new developments, and future recommendations.

FISCAL YEAR 2017 ACCOMPLISHMENTS

- Task 1: Literature Review
 - The research team documented the state-of-the-practice for traffic clustering methods used in other states. Federal Highway Administration (FHWA) recommendations for clustering traffic inputs among various locations (included in the "Traffic Monitoring Guide") were reviewed and documented.

- Task 2: Review of Current MDOT Practices
 - The critical review of the current MDOT practices (based on 2009 traffic study) was completed. Applied Research Associates (ARA) evaluated the appropriateness of the current clustering methodology in the State of Michigan. A memo on the summary of findings and recommendations from this review was submitted to MDOT for the approval of Task 3. The WIM and Classification data for the years 2011 to 2015 were used to develop all traffic input levels (combined for all years, and by individual year) based on the existing methodology. The following approaches were proposed for Task 3 as approved by MDOT:
 - Improved existing methodology (2A) and
 - Alternative simplified methodology (2B).
- Task 3: Methodology for Clustering
 - The approaches (2A & 2B) need generation of Level 2 inputs based on the new traffic data. For the Improved Existing Methodology, different proximity measures and clustering techniques were reviewed. Based on this review, Euclidean distance and Ward's linkage method (agglomerative hierarchical approach) were used to generate clusters based on new traffic data.
 - For the Alternative Simplified Methodology, road functional class (Freeway vs. Non-freeway), development type (Urban vs. Rural), Average Annual Daily Truck Traffic (<1000, 1000-3000, >3000), corridors of highest significance (National, Regional and Statewide), national functional class (Interstates, Other Freeways, and Others), number of lanes (2, 3 and 4), and road type (divided, freeway etc.) were selected as potential attributes used to generate Level 2 inputs.
- Task 4: Generation of New Clusters for Level 2 Data
 - For the Improved Existing Methodology, the following work was accomplished:
 - Level 2 clusters were generated for Vehicle Class Distribution (VCD), Hourly Distribution Factor (HDF), Monthly Adjustment Factor (MAF), and Axle Load Spectra (ALS) for single, tandem, tridem and quad axle types.
 - For the Alternative Simplified Methodology, the following work was performed:
 - Level 2 traffic inputs were generated for VCD, HDF, MAF, and ALS for single, tandem, tridem and quad axle types for each of the attributes outlined in the work done in Task 3. Note that the final selection of attributes used to generate Level 2B cluster data has not yet been determined.
 - Also, two Level 3 inputs were generated based on functional class (Freeway and Non-freeway) and statewide averages. These Levels designated as:
 - Freeway and Non-freeway (3A)
 - Average of all traffic data (3B)
- Task 5: Significant Traffic Inputs
 - Sensitivity analyses were performed for Level 2A, 3A, and 3B traffic inputs based on flexible pavements.

FISCAL YEAR 2018 ACCOMPLISHMENTS

- Task 3: Methodology for Clustering
 - Compared the results between the two approaches, Level 2A and 2B for accuracy and ease used
 - Developed cluster assignment methodologies
- Task 4: Generation of New Clusters for Level 2 Data
 - Decided on the attributes used to generate traffic inputs for the Simplified Methodology, Level 2B
 - Finalized the clusters and groupings based on sensitivity analysis
- Task 5: Significant Traffic Inputs
 - Conducted sensitivity for flexible pavements for Level 2B
 - Conducted sensitivity for rigid pavements
- Task 6: Evaluation of PrepME
 - Had Oklahoma State University update PrepME based on the results of the research
 - Developed tools to update Level 2A and 2B as needed
- Task 7: Data Collection Recommendations
 - Provided final recommendations, including data to use, how often to update, and how to improve future data
- Task 8: Final Report and Technology Transfer
 - Provided technology transfer for the Department
 - Delivered Final Report and updated PrepME software, software for updating clusters, and resulting traffic inputs

FISCAL YEAR 2019 ACCOMPLISHMENTS

This project was completed during FY 2018; however, some additional MDOT project management costs posted at the beginning of FY 2019.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

A project extension to 8/31/2018 was approved on 3/22/2018 which allows time for additional analysis of the data.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

MDOT will determine which of the two Level 2 options, 2A or 2B, to use for Pavement ME design. This determination is based on the practicality and ease of integration per the methodology. The analysis will begin with MDOT central office (January 2019) and then move to MDOT traffic planners for their input. After both parties are satisfied (by March 2019), the selected method will be presented to the rest of MDOT and interested external partners (May 2019). The selected methodology and its data will be used for MDOT ME pavement designs with full implementation expected by June 2019.

Modifications to the Prep-ME software based on results of the study were implemented. Additionally, MSU provided deliverable software that can be used to update and provide Level 2 inputs per 2A or 2B. This deliverable was made for use outside of Prep-ME as necessary.

As noted in the report, MDOT will consider revising the results of this study if the following changes occur:

- New PTR site(s) or changes to an existing site
- Route or land use change near PTR site(s)
- Changes in PTR technology (software or hardware)

MDOT will continue to monitor PTR data for changes in traffic pattern data (classifications and loadings). If changes are observed at a PTR location for 3 consistent years, then the latest 3 years of traffic data will be used to update traffic inputs and Level 2 data. This process is performed using the selected methodology (2A or 2B) and appropriate software (Prep-ME or MSU deliverable software).

MDOT will continue to expand the geographic coverage of traffic data from Michigan PTR sites and this report supports that effort.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Applying Multi-Beam Sonar for Inspection for Bridge Scour and Performance of Bridge Scour Mitigation Methods

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Chad Skrocki

CONTRACT/AUTHORIZATION NO.	2016-0430	PROJECT START DATE	10/1/2016
PROJECT NO.	131752	COMPLETION DATE (Original)	12/31/2018
OR NO.	OR15-192	COMPLETION DATE (Revised)	5/31/2019
RESEARCH AGENCY	Ayres Associates		
PRINCIPAL INVESTIGATOR	Brian Schroeder		

BUDGET STATUS

FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$341,244.02	Total Vendor Budget	\$589,641.35
MDOT Budget FY 2019	\$2,000.00	Total MDOT Budget	\$8,223.67
Vendor FY 2019 Expenditures	\$313,965.05	Total Budget	\$597,865.02
MDOT FY 2019 Expenditures	\$5,540.31	Total Expenditures	\$570,588.06
		Total Amount Available	\$27,276.96

PURPOSE AND SCOPE

MDOT's risk-based management of bridges for scour vulnerability relies upon accurate inspection for bridge scour and performance of scour mitigation methods such as riprap and articulating concrete block systems. Technology and procedures to safely and effectively perform scour inspections when the river is deep, fast flowing, and turbid are needed. This project will determine the feasibility of using multi-beam echo sounding technology for determining scour along bridge foundations during and after significant events, perform field investigations using the technology to confirm countermeasure effectiveness, develop procedures and cost analysis for the use of the technology on manned and unmanned vessels, procure and deliver operable equipment, and train MDOT staff to conduct unmanned multi-beam echo sounding.

FISCAL YEAR 2017 ACCOMPLISHMENTS

The Research team collected information on best practices for the use of the proposed technology. The team also contacted vessel manufactures and completed site visits to help determine the proper equipment that will meet MDOT's requirements.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Several field demonstrations were performed over the course of 2018. The vessels that were demonstrated were the Echo Boat from Seafloor systems, the sonar EMILY from Hydronalix, and a custom RC boat the was retrofitted with sonar equipment by Ayres Associates. Ayres also attended a field demonstration for the T-6 MANTA by Martac, but it was determined that this boat was too expensive. The purpose of the field demonstrations was to determine which boat would meet MDOT's needs with an emphasis on speed, maneuverability, simplicity of sonar equipment, and range required for real time viewing of collected data. The only boat to meet minimum requirements was the Sonar EMILY boat. One more field demonstration for the Sonar EMILY is scheduled for October 26th before a final decision is made.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The Sonar EMILY vessel manufactured by Hydronalix was selected in late 2018 and acquired in March of 2019. A 2-day formal training session was put on by Hydronalix and Vince Capone (Sonar expert / SAR Hawk supplier) for MDOT bridge inspectors from every region. After the training, Ayres Associates finalized the report and user manuals. MDOT received all submittals and equipment by June of 2019. Since the completion of the project, several regions have utilized the equipment to perform scour inspections.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

A Project Manager change was approved on 3/22/2018. Another contract revision was approved 12/17/2018 to extend the end date due to the onset of winter and need for additional time to acquire and implement the Sonar EMILY boats.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Since the completion of the project, several regions have shown an interest in utilizing this equipment to perform scour inspections. It is recommended that inspectors from each region continue to use the equipment on a regular basis to stay efficient and knowledgeable. Chad Skrocki (Research PM) will continue to work with the regions to provide one on one training as needed.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Commercial Production of Non-Proprietary Ultra High-Performance Concrete (UHPC)			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Steve Kahl			
CONTRACT/AUTHORIZATION NO.	2016-0068 Z6	PROJECT START DATE	4/1/2017
PROJECT NO.	132225	COMPLETION DATE (Original)	3/31/2018
OR NO.	OR16-007	COMPLETION DATE (Revised)	12/31/2018
RESEARCH AGENCY	University of Michigan		
PRINCIPAL INVESTIGATOR	Sherif El-Tawil		
BUDGET STATUS			
FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$5,619.26	Total Vendor Budget	\$183,385.67
MDOT Budget FY 2019	\$0.00	Total MDOT Budget	\$0.00
Vendor FY 2019 Expenditures	\$0.00	Total Budget	\$183,385.67
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$183,385.67
		Total Amount Available	\$0.00

PURPOSE AND SCOPE

Ultra-High Performance Concrete (UHPC) is a specially formulated concrete with exceptional characteristics. The primary commercially available UHPC on the US market is available through LaFarge and marketed as Ductal®. Ductal is a proprietary material that is much more expensive than regular concretes (about two orders of magnitude more). Construction using Ductal and other similar materials available through European suppliers requires specially certified contractors and costly construction processes, such as pressure or heat treatment, which are impractical to achieve in the field. Extremely high material cost coupled with complicated and costly construction procedures have seriously delayed widespread adoption of UHPC in the US. U of M developed a non-proprietary UHPC mixture that doesn't require specialized crews or curing procedures in an earlier MDOT research sponsored project "Development, Characterization and Applications of a Non Proprietary Ultra High Performance Concrete for Highway Bridges". The resulting material had performance characteristics similar to the commercially available material. However, after a successful lab batch was optimized, the research team couldn't achieve successful field mixing. Since the conclusion of the project, U of M has experimented with various other mixtures and were able to successfully mix 1/3 Cubic Yard (CYD) at a commercial mixing facility. The new mix differs from the old in two ways: 1) the amount of super-plasticizer was changed, and 2) the mixing procedure was altered. The effect of key research variables on mixing behavior and material characteristic remain unknown at present and therefore additional research is needed. In particular, scale up beyond 1/3 CYD needs to be explored. The effect of other kinds of commercially available ingredients on material properties should be investigated so that special provisions for the material are not restrictive. The effect of mixing temperature and protocols on material characteristics also need to be investigated. All of these issues need to be considered while ensuring that material cost remains competitive. The scope of work for this project includes the following tasks:

1. Perform analysis of unsuccessful field mixing to determine why a component differing from the lab mix leads to failure, analyze and account for the differences in lab scale and production scale equipment;
2. Optimize the mix design for commercially available cements, silica fume, and admixtures; determine optimal properties of steel or polymer fibers;
3. Research commercially available batch mixer designs and purchase a batch mixer for experimentation and future MDOT use.
4. Run batches on progressively larger equipment (1/3 cyd mixer to 3 cyd-redi-mix) and validate the optimized mix;
5. Provide material specifications and any contraindications; provide mixing recommendations

FISCAL YEAR 2017 ACCOMPLISHMENTS

Task 1 – Analysis of Failed Batches has been concluded.

Task 2 - Optimize Mix for Short- and Long-Term Properties

Numerous trial mixes have been tested in the lab (approximately 80) to identify the effect of key short-term variables including: 1) test age, 2) type of silica fume, 3) fiber length and dosage, 4) type and amount of High Range Water Reducer (HRWR), 5) grade of slag cement (Gr 100 or Gr 120), and 5) Water to Cement (W/C) ratio. The test matrices listed in the proposal are almost done.

Task 3 – Research Commercially Available Batch Mixer Designs

The Mortarman 750 model has been identified a feasible mixer. In discussions with MDOT, the preference of MDOT engineers is the gas version, not electrical. The mixer can be directly shipped to MDOT for piloting UHPC.

Task 4 – Scaled-up Batch Mixing

This task was completed during the August 2017 field pour for the Kilgore Road over the Pine River bridge structure replacement. UHPC was successfully used for closure pours between prefabricated beam elements.

FISCAL YEAR 2018 ACCOMPLISHMENTS

All tasks were completed, including task 5, development of special provisions. Final report was submitted.
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FISCAL YEAR 2019 ACCOMPLISHMENTS

Final report received and accepted.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
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A project extension to 12/31/2018 was approved on 3/31/2018 to allow for long term testing that will take longer than originally scheduled.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Ensure use of the non-proprietary UHPC on bridge projects for precast construction.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Best Practices for Modernizing MDOT Bridge Design Manual, Guides, and Policy Documentation			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (<i>PLEASE EXPLAIN</i>)			
PROJECT MANAGER: Bradley Wagner			
CONTRACT/AUTHORIZATION NO.	2016-0070 Z5	PROJECT START DATE	1/18/2018
PROJECT NO.	132227	COMPLETION DATE (Original)	4/30/2019
OR NO.	OR16-006	COMPLETION DATE (Revised)	12/31/2019
RESEARCH AGENCY	Wayne State University		
PRINCIPAL INVESTIGATOR	Haluk Aktan, Ph.D.		
BUDGET STATUS			
FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$207,181.24	Total Vendor Budget	\$282,341.92
MDOT Budget FY 2019	\$3,600.00	Total MDOT Budget	\$2,400.00
Vendor FY 2019 Expenditures	\$156,158.81	Total Budget	\$284,741.92
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$188,400.41
		Total Amount Available	\$96,341.51
PURPOSE AND SCOPE			
MDOT often makes policy decisions based on experience, feedback from stakeholders, and the technical expertise of the MDOT Bridge Committee. When decisions are implemented into our manual and guides, they include direction without giving the background for changes. The purpose of this project is to assemble historical bridge design policy information, research best practices among states and determine a way to document decisions, make information accessible and modernize manuals and guides.			
FISCAL YEAR 2018 ACCOMPLISHMENTS			
The project kicked off in February 2018. Completed literature review (Task 1) and digitized policy information (Task 3). Began establishing background for policy (Task 2). The project team also submitted a proposed workflow for evaluation by MDOT and began working on a recommendation of a system for linking policy decisions (Task 4). A functional specification is currently being reviewed by MDOT.			
FISCAL YEAR 2019 ACCOMPLISHED			
All original tasks for this project were completed. The draft final report was submitted in January of 2019. Through review of this final report, it was determined that additional time and budget was required to complete the project and ensure historical documentation was as organized and as accessible as possible. A decision was made to forego updates to the manuals and repurpose some funds to finalize the project. An extension of time to 12/31/2019 and a cost increase of \$39,165.50 was approved.			
FISCAL YEAR 2020 PROPOSED ACTIVITIES			
In FY 2020, a revised final report is anticipated in October of 2019, and a completed historical archive will be submitted in November of 2019. A final project meeting will be held in November, and a webinar will be conducted in December to disseminate the findings of the project to bridge design stakeholders.			
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))			
A contract revision was approved on 5/29/2019 to increase the cost due to additional scope of work, as well as extend the project end date. Some scope was added to ensure historical data is well organized and accessible, and to finalize a more formal workflow for implementing new policy changes.			
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)			
Project expected completion in FY 2020.			

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Develop and Implement a Freeze Thaw Model Based Seasonal Load Restriction Decision Support Tool			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Melissa Longworth			
CONTRACT/AUTHORIZATION NO.	2016-0067 Z5	PROJECT START DATE	4/1/2017
PROJECT NO.	132228	COMPLETION DATE (Original)	3/31/2019
OR NO.	OR16-009	COMPLETION DATE (Revised)	3/31/2020
RESEARCH AGENCY	Michigan Technological University		
PRINCIPAL INVESTIGATOR	Zhen Liu		
BUDGET STATUS			
FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$70,466.22	Total Vendor Budget	\$164,952.18
MDOT Budget FY 2019	\$11,000.00	Total MDOT Budget	\$1,753.51
Vendor FY 2019 Expenditures	\$71,603.49	Total Budget	\$166,705.69
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$151,037.67
		Total Amount Available	\$15,668.02
PURPOSE AND SCOPE			
<p>This research seeks to build on the foundation of research from "MDOT's research project Predictive Modeling of Freezing and Thawing of Frost-Susceptible Soils Report Number: RC 1619" to establish a thawing model and a process for setting and removing seasonal load restrictions in a manner that will give industry the most amount of time to prepare for the restrictions and minimize the time to lift the restrictions. This project will evaluate existing models for possible refinement, establish a data format and multiple sources for soil and air temperatures, develop a thaw depth model using existing data sources, identify locations for data collection sites, and develop a decision support tool along with training materials.</p>			
FISCAL YEAR 2017 ACCOMPLISHMENTS			
<p>The project kick off meeting was held on 5/12/2017. The Principal Investigator (PI) and Research Advisory Panel (RAP) also held discussions to help further determine project direction. A pilot web- based tool was developed, designed and optimized for mobile devices like tablets and cell phones. Some work has been done to test the data needed for this project, along with testing potential weather, Graphic Information System (GIS), and Road Weather Information System (RWIS) data and models for Seasonal Load Restriction (SLR) and freezing/thawing depths. The PI has requested access to RWIS data Application Programming Interface (API) and has started looking at the possibility of linking to this data. The PI has also had discussions with experts from Minnesota and Alaska Departments of Transportation. The Federal Highway Administration (FHWA) model for SLR predictions and two new statistical models for freezing and thawing depth predictions were also successfully implemented. The predictions are very close to that made by Thawcaster.</p>			
FISCAL YEAR 2018 ACCOMPLISHMENTS			
<p>PI and team have developed the mdotslr.org tool and have been testing the data on the website to make sure models are working correctly and accurately. The PI has researched Minnesota weather data, and Thawcaster weather data for comparison. Models for SLR predictions and freezing/thawing depth predictions have been further explored. Models are being checked with historical Michigan data to see how they relate to actual SLR dates used in Michigan. MDOT's RWIS API data has been incorporated. Contact was made to the Aurora project to minimize duplication and remain in alignment with national efforts. A mid-term meeting was held with RAP on August 24th to review progress to date and provide further direction for project.</p>			
FISCAL YEAR 2019 ACCOMPLISHED			
<p>PI completed the import of historical RWIS data and updated the freezing and thawing depth prediction models at mdotslr.org, as well as developed SLR prediction models. MDOT's weather data source was incorporated. The team met on August 27th to go over research materials and draft final report. MDOT provided feedback on the tool and the tool was updated accordingly.</p>			
FISCAL YEAR 2020 PROPOSED ACTIVITIES			
<p>PI and team will plan, coordinate and hold a training event for rollout of this decision support tool. Additional scope is pending approval that will add GIS frost tube data to the mdotslr.org tool.</p>			
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))			
<p>The end date was revised and approved on 11/14/2018 to extend the project until 8/30/2019. The extension will ensure there is time to develop training materials at the completion of the project. The end date was extended until March of 2020. An additional scope and cost has been proposed and is pending approval.</p>			
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)			
<p>Project revised completion date is March 31, 2020. The mdotslr.org tool will be available for use in 2020.</p>			

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Signal Performance Measures Pilot Implementation			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Doug Adelman			
CONTRACT/AUTHORIZATION NO.	2017-0285	PROJECT START DATE	11/1/2016
PROJECT NO.	132229	COMPLETION DATE (Original)	12/31/2018
OR NO.	OR16-002	COMPLETION DATE (Revised)	
RESEARCH AGENCY	AECOM		
PRINCIPAL INVESTIGATOR	Matt Klawon, PE		
BUDGET STATUS			
FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$47,085.90	Total Vendor Budget	\$224,590.10
MDOT Budget FY 2019	\$10,000.00	Total MDOT Budget	\$27,858.53
Vendor FY 2019 Expenditures	\$37,394.33	Total Budget	\$252,488.63
MDOT FY 2019 Expenditures	\$8,498.99	Total Expenditures	\$242,757.06
		Total Amount Available	\$9,691.57
PURPOSE AND SCOPE			
Implement and evaluate signal performance measures on the following two signalized corridors: <ul style="list-style-type: none"> ○ Nine traffic signals along US-31 in Holland. ○ Three traffic signals along US-31 in Traverse City 			
FISCAL YEAR 2017 ACCOMPLISHMENTS			
Shop and field test Utah software with typical communications equipment used by MDOT. Configured Utah software to be able to implement signal performance measures. Programmed and validated proper detection mapping and operations. Deployed Bluetooth data devices to confirm signal performance data. Began initial monitoring of signal performance for the Holland corridor. Identified server and database constraints for current and future deployments.			
FISCAL YEAR 2018 ACCOMPLISHMENTS			
Completed monitoring of Holland and Traverse City corridors. Initiated signal timing changes as identified during monitoring, and quantified operational benefits. Defined a cost/benefit analysis evaluation methodology and began a cost/benefit analysis on the implementation of the signal performance measures along the Holland and Traverse City corridors. Began final research report.			
FISCAL YEAR 2019 ACCOMPLISHMENTS			
Held an Executive Research Reporting meeting on December 6, 2018 and a Technical Training meeting on December 10, 2018. The researcher submitted a final report to MDOT, along with all required final deliverables.			
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))			
This contract was revised on January 18, 2017 to correct the project end date. A budget shift was approved on 1/9/2018 to cover the cost of more computing power and database capability for Wayne State University (subcontractor).			
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)			
Resulting performance measures from the research demonstrate this pilot project has a Benefit to Cost Ratio of 2.8 to 1 based on calculated annualized user delay benefits of \$1,048,957 and actual incurred costs of \$370,554.00. MDOT's mission includes providing the highest quality integrated transportation system, which will require more active management of traffic signal operations and maintenance. Automated Traffic Signal Performance Measures (ATSPMs) are one of the strategies available to assist staff to more efficiently operate and maintain traffic signals, but additional resources will be required to implement and utilize such a system. Sample implementation plans were provided, including estimated staffing resources required for ATSPM deployment. The extent MDOT will choose to implement depends on the availability of funds to cover anticipated costs.			

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Slope Restoration on Urban Freeways

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Nanette Alton

CONTRACT/AUTHORIZATION NO.	2013-0066 Z10	PROJECT START DATE	4/1/2017
PROJECT NO.	132231	COMPLETION DATE (Original)	7/31/2019
OR NO.	OR16-008	COMPLETION DATE (Revised)	4/30/2021
RESEARCH AGENCY	Michigan State University		
PRINCIPAL INVESTIGATOR	Bert Cregg		

BUDGET STATUS

FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$123,846.94	Total Vendor Budget	\$476,941.06
MDOT Budget FY 2019	\$20,000.00	Total MDOT Budget	\$50,197.72
Vendor FY 2019 Expenditures	\$80,370.62	Total Budget	\$527,138.78
MDOT FY 2019 Expenditures	\$18,816.62	Total Expenditures	\$309,912.43
		Total Amount Available	\$217,226.35

PURPOSE AND SCOPE

The purpose of this project is to research and subsequently develop best practices and viable alternatives to turf as a solution for slope stabilization, especially steep slopes. Current methods and practices necessary to specify correct soils, plant species, cultural practices, planting standards, maintenance plans, benefits, and costs will be analyzed. The result will be best practice recommendations for slope restoration and continued maintenance. The scope of work includes the following tasks:

1. Analyze existing research regarding erosion control, restoration, and maintenance on steep slopes adjacent to freeways.
2. Identify field research plot location(s) in the I-696 corridor.
3. Provide MDOT with research work plan.
4. Partner with MDOT and vendor installation contractor to provide oversight on installation.
5. Perform subsequent maintenance of research plots.
6. Collect data.
7. Review and analyze data collected to determine best practices and cost-benefit ratios.
8. Identify best practices for site preparation.
9. Identify native and non-native trees, shrubs, herbaceous perennials, and grasses suitable for Michigan roadside plantings. Compile research from the current project as well as a review of literature of similar studies and relevant guides from other DOT's to develop a new MDOT Plant Selection Guide
10. Present research results with final recommendations.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Hired Research Technician for the project (Deborah Trelstad), finalized plot site selection, and marked research plot boundaries. Collected mulch, compost and soil samples from study area. Also identified comparative areas along I-696 (outside of study blocks) and initiated sampling and assessment, of areas where establishment was successful. Hired a designer to complete plot design drawings for bid specs and a graduate student (Liza Christopher) initiated literature review of related roadside planting protocols from DOT's in other states. MDOT did not completed the planting in fiscal year 2017 as originally planned.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Plot designs and plant lists were completed by MSU. MSU reviewed literature of related roadside planting protocols from DOT's in other states as well as roadside salts. The contractor for plot installation was selected (WH Canon) and installation started June 15, 2018. Plot installation and planting completed for blocks 4-6 and 4a-6a. Over 50 percent of plant installations were completed in 2018 in coordination with major construct of I-696 and despite operators strike. MDOT facilitated watering operations between local municipalities, MDOT, researchers and contractors. MDOT region provided additional funding for plant replacement due to mortality from I-696 construction damage and 2018 summer drought. MSU measured leaf chlorophyll index on Cornus, Physocarpus, Forsythia and Dierivilla plants in blocks 4-6. Collected leaf tissue for nitrogen (N) analysis. They also installed rain gauges data loggers/ temperature sensors on the plots and collected data. Periodic growth measurements taken for blocks 4-6 and 4a-6a.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Contractor completed installation of study treatments and plants in Blocks 1-3 in October 2018 on North side of I-696 West and East of the Nieman St. overpass. Sites for Blocks 1-3 were moved from their original planned locations to avoid additional lane closures during I-696 construction in Summer-Fall 2018. MSU researchers installed soil moisture sensors, soil temperature sensors and automatic data loggers in each plot. Data collection continued on the site throughout the 2019 growing season and included plant growth, plant moisture stress, plant nutrient status, and photosynthetic rate. MSU Personnel conducted periodic maintenance on the plots including hand-weeding and application of pre and post-emergent herbicides. Project was amended to allow for longer-term (5 years) evaluation of the

test plantings. In conjunction with project amendment, MSU Researchers developed a proposal for additional funding through MSU project GREEN, which was funded at \$35,000 per year for two years (\$70,000 total). The grant funding will provide continuing support for an M.S. graduate student at MSU. Preliminary results of the project indicate the addition of compost greatly improved plant establishment and growth. The response of plants to compost appears to be primarily related to improve plant nutrient availability. To date, tillage appears to provide relatively little benefit for plant establishment and growth.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Plant growth, plant physiology, and soil measurements will resume in spring 2020 and continue throughout the growing season. MSU personnel will provide an update on the project at the Michigan Nursery and Landscape Association Great Lakes Trade Expo in January 2020. MSU Personnel will work with PM to develop a plant selection guide for Michigan Roadsides. The guide will be based on results from the current research as well as existing literature. MSU personnel will expand above-ground environmental monitoring to include two automated weather stations, one on the south side of I-696 and one on the north side of I-696. These stations will provide detailed micro-climate information to characterize the plant environment on the contrasting sites (north vs south slopes). MSU will use equipment currently in hand for one weather station and develop a proposal for the Michigan Department of Agriculture and Rural Development Horticulture fund to purchase equipment for the second for the second.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

A Project Manager (PM) change was approved on 3/13/2018 making Nanette Alton the new PM. The previous PM was Bill Stonebrook. Another contract revision was approved 7/15/2019 that added scope and budget as well as extending the end date to 4/30/2021. The scope addition was a deliverable for documenting plant recommendations to replace outdated MDOT guidance. Years were added to study long term plant viability. One additional year was needed because of delays associated with the planting phase.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion in FY 2021.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: 3D Highway Design Model Cost Benefit Analysis			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: John Wilkerson			
CONTRACT/AUTHORIZATION NO.	2017-0606	PROJECT START DATE	7/1/2017
PROJECT NO.	132232	COMPLETION DATE (Original)	10/31/2018
OR NO.	OR16-004	COMPLETION DATE (Revised)	2/28/2019
RESEARCH AGENCY	WSP Michigan Inc.		
PRINCIPAL INVESTIGATOR	Alexa Mitchell		
BUDGET STATUS			
FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$64,639.40	Total Vendor Budget	\$204,616.47
MDOT Budget FY 2019	\$1,169.00	Adjusted MDOT Budget	\$0.00
Vendor FY 2019 Expenditures	\$50,847.39	Total Budget	\$204,616.47
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$190,824.46
		Total Amount Available	\$13,792.01
PURPOSE AND SCOPE			
<p>The purpose of this project is to obtain a quantifiable understanding of the usage, benefits and savings resulting from Reference Information Documents (RID), with or without 3D models. This is intended to inform future decision-making regarding policies and uses of digital deliverables. This will be accomplished by determining the return on investment of supplying 3D model and RID information through researching construction costs and schedules for savings, investigating and documenting what information is being used and how it is being used, considering what RID information would be beneficial to the user if it was part of the contract, and analyzing potential and actual risk reduction associated with providing RID or 3D models. The scope of work for the project includes the following tasks:</p> <ol style="list-style-type: none"> 1. Collection and review of return on investment data. 2. return on investment analysis 3. Industry investigation of current use of RID 4. Investigation of digital data that could become part of the contract to improve the quality and reduce the cost of construction. 5. Collection and review of risk reduction data. 6. Reporting and knowledge transfer 			
FISCAL YEAR 2017 ACCOMPLISHMENTS			
<p>A project kickoff meeting was held with all stakeholders having the opportunity to participate, followed by the development of a survey questionnaire to gain information on the benefits of RID for contractors, designers and consultants. The researcher also began to research the cost benefits gained to date from MDOT projects utilizing 3D models and RID information.</p>			
FISCAL YEAR 2018 ACCOMPLISHMENTS			
<p>WSP submitted a draft final report outlining benefits of RID and 3D modeling in September 2018. The report included analysis of project cost savings, interviews with MDOT construction staff, and surveys of construction contractors and design consultants. Recommendations for improvements to the RID and 3D model process to provide potential and actual risk reduction from RID and or 3D models were scheduled to be discussed prior to submittal of the finalized report.</p>			
FISCAL YEAR 2019 ACCOMPLISHMENTS			
<p>A final presentation and workshop to discuss recommendations for risk reduction and implementation of RID and 3D models occurred in mid-February 2019, and WSP submitted the final report at the end of February 2019. The report was then published and summarized for Bureau of Development leadership in the Spring of 2019. This project has now ended.</p>			
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))			
<p>A project extension to 2/28/2019 was approved on 9/20/2018 to allow proper planning and execution of the final presentation and workshop.</p>			
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)			
<ul style="list-style-type: none"> • Developing an educational outreach program around modeling for infrastructure, training construction staff, and engaging project development and asset inventory staff. • Implementation of multi-disciplinary collaboration processes are recommended to maximize the utility of models and ensure greater collaboration during the review process to improve construction document accuracy and compliance. 			

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- Level of Development Specifications should be established and may be based on Model Density and Confidence level terms per a recent FHWA study (Maier, et al 2017) cited in the report.
 - Draft Special Provisions and Contractor Requirements are included with the report deliverables as part of the recommendations.
 - A Return on Investment Calculation Spreadsheet created by WSP for the project could be used to update expected return rates on projects.
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**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Bridge Structural Analyses for Staged Construction and Constructability Review

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Peter Jansson

CONTRACT/AUTHORIZATION NO.	2016-0070 Z3	PROJECT START DATE	7/1/2017
PROJECT NO.	200837	COMPLETION DATE (Original)	9/30/2019
OR NO.	OR15-181b	COMPLETION DATE (Revised)	4/1/2020
RESEARCH AGENCY	Wayne State University		
PRINCIPAL INVESTIGATOR	Haluk Aktan		

BUDGET STATUS

FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$165,898.08	Total Vendor Budget	\$295,937.12
MDOT Budget FY 2019	\$0.00	Adjusted MDOT Budget	\$10,000.00
Vendor FY 2019 Expenditures	\$62,938.95	Total Budget	\$305,937.12
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$154,635.99
		Total Amount Available	\$151,301.13

PURPOSE AND SCOPE

The purpose of this project is to develop calculation templates to address common constructability analyses, review stresses, and verify design assumptions at each stage of bridge construction to prevent overloading of structural elements during construction. Structural elements considered for analysis include: Girders, decks, diaphragms, cross frames, stiffeners, bearings, and any other elements that transmit construction loading. Primary project tasks are to

1. Identify the most important construction issues/cases to be addressed,
2. List the key components of constructability reviews for MDOT bridge projects,
3. Create the actual templates, manuals, and guides with examples,
4. Present implementation recommendations.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Second kickoff meeting held with new university and revised Research Advisory Panel (RAP) members. Survey submitted for MDOT approval. Reviewed MDOT MIBridge inspection records and compiled MDOT case studies for review.

FISCAL YEAR 2018 ACCOMPLISHMENTS

The Literature Review is nearly complete. A Review of MDOT Case studies has begun with a draft survey being modified for design and construction. Two common design and constructability document review items have been developed: 1) Deck overhang concrete placement models and 2) Excel framework of constructability checks.

Research advisory meeting was held on October 3, 2018.

1. Constructability Evaluation Framework was discussed with the following major categories:
 - a. Transportation and Lifting
 - b. Erection
 - c. Deck Placement
 - d. Phased Construction
 - e. There was also interest in looking at methods of construction to address deformation, capacity, and stability related issues.
2. Construction Activity Responsibilities were discussed
3. Constructability checklist for MDOT inspectors was circulated and reviewed with MDOT providing feedback.
4. Constructability evaluation tools were reviewed. This included a spreadsheet system that identifies design concerns for various types of bridges with specific geometries and then recommends an analysis tool.
5. A MathCAD template example was presented for formwork rotation during deck placement. Inputs include:
 - a. Bridge and Girder Geometry,
 - b. Material Properties,
 - c. Falsework, Formwork and Equipment Properties,
 - d. Component and Construction Loads.

Output is rotational deformation of beam and other measures of stability.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Preliminary spreadsheets in MathCAD and Microsoft Excel have been developed for common construction issues and constructability. Checklists have also been developed to aid field staff and central office staff. They have been reviewed and MDOT comments were provided. Survey results were also provided to the researchers.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Refinement of spreadsheets and checklists based on MDOT comments is expected. Additional similar work based on increased scope to address more recent fabrication/construction issues that occurred after the project started will be done. Assessment of survey results and review of specific MDOT project issues within the confines of the research project scope to further refine spreadsheets and checklists will be completed. Submittal of the draft project report is due in the spring.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

A no cost time extension was granted 6/7/2018 to allow additional time for WSU to conduct an MDOT survey, ensuring they receive clear project direction. An additional extension was approved 10/14/2019 to provide additional time to receive more input on constructability priorities. An extension, scope, and budget change was proposed in FY 19 and will be processed in FY 2020. Additional scope includes evaluating literature, developing a calculation tool, including more information in the training manual. The revised completion date will be 4/1/2020.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion in FY 2020.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Effects of Concrete Cure Time on Epoxy Overlay and Sealant Performance			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: John Belcher			
CONTRACT/AUTHORIZATION NO.	2016-0069 Z6	PROJECT START DATE	7/1/2018
PROJECT NO.	201393	COMPLETION DATE (Original)	12/31/2019
OR NO.	OR17-201	COMPLETION DATE (Revised)	12/31/2021
RESEARCH AGENCY	Western Michigan University		
PRINCIPAL INVESTIGATOR	Upul Attanayake, Ph.D., P.E.		
BUDGET STATUS			
FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$180,148.53	Total Vendor Budget	\$390,572.79
MDOT Budget FY 2019	\$8,500.00	Total MDOT Budget	\$16,700.00
Vendor FY 2019 Expenditures	\$185,890.15	Total Budget	\$407,272.79
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$194,338.51
		Total Amount Available	\$212,934.28
PURPOSE AND SCOPE			
<p>MDOT currently waits 28 days after the placement of all concrete decks, rigid overlays, and patches on bridge decks before placing epoxy overlays and sealants. Often this extended period conflicts with traffic and weather limitations. With more information on the crack development and moisture release characteristics of MDOT standard concrete materials (Grade D, DM, SFMC, LMC, etc.) and special/patching mixtures MDOT could potentially reduce the time required between placement.</p> <p>The objectives of this project include the following:</p> <ol style="list-style-type: none"> 1. Research criteria and benefits of epoxy overlay and sealant placement timing with regards to standard materials and special/patching material. 2. Develop a testing plan that encompasses the material used by MDOT. 3. Prepare specimens and conduct QAQC testing. 4. Evaluate overlay/sealant performance vs crack development and curing. 5. Analyze results and quantify the cost savings. 6. Recommend a procedure for determining overlay/sealant placement timing based on material/mix design. <p>The scope of work for this project includes the following tasks:</p> <ol style="list-style-type: none"> Task 1. Review state-of-the-art and state-of-the-practice. Task 2. Develop a testing plan that encompasses the material used by MDOT. Task 3. Prepare specimens and conduct QAQC testing. Task 4. Evaluate overlay/sealant performance vs crack development and curing. Task 5. Evaluate long-term bond strength and concrete durability properties of epoxy overlay. Task 6. Analyze results and quantify the cost savings. Task 7. Produce final research report. 			
FISCAL YEAR 2018 ACCOMPLISHMENTS			
The team was able to establish which testing protocols and mix designs will be included in the research.			
FISCAL YEAR 2019 ACCOMPLISHMENTS			
Tasks 1 through the initial intent of 4 are complete. Work was added to task 4 for FY 2020.			
FISCAL YEAR 2020 PROPOSED ACTIVITIES			
Completion of tasks 4-6.			
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))			
On 6/6/2019, funds were shifted within the existing budget to cover the purchase of new equipment to manage the work schedule and case a set of new slabs to collect additional data for clarifying observation results. A contract revision was also approved on 9/30/2019 to add scope and costs for additional studies to evaluate material outside of the laboratory for a longer period, which also extended the project end date.			
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)			
Project Expected Completion FY 2021.			

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Accelerated Bridge Preservation Techniques			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Eric Burns			
CONTRACT/AUTHORIZATION NO.	2018-0074	PROJECT START DATE	1/29/2018
PROJECT NO.	201396	COMPLETION DATE (Original)	1/29/2020
OR NO.	OR17-203	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University		
PRINCIPAL INVESTIGATOR	Judith Corley-Lay, Ph.D., P.E.		

BUDGET STATUS			
FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$98,521.10	Total Vendor Budget	\$130,773.50
MDOT Budget FY 2019	\$5,000.00	Total MDOT Budget	\$5,797.60
Vendor FY 2019 Expenditures	\$57,845.55	Total Budget	\$136,571.10
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$80,784.32
		Total Amount Available	\$55,786.78

PURPOSE AND SCOPE

A sound asset management program involves a mix of fixes including preservation, rehabilitation and replacement. The most efficient method is preservation at the right time to allow deferment of replacement but many preservation activities impact traffic and come with additional traffic control costs. This study will evaluate the mobility impacts of typical MDOT preservation activities, identify any accelerated preservation methods successfully used in other states or sectors, and evaluate the long-term programmatic impacts of multiple preservation interventions as compared to the impact of emergency maintenance actions, bridge replacements and heavy maintenance. A life cycle mobility framework will be created to provide cost/benefit information to the decision maker at project scoping.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Survey 1 was distributed to state agencies and local agencies who participate in the bridge preservation partnerships. In addition, the responses on traffic control requirements have been used to set low, medium and high options for traffic control that will be included in Survey 2. Efforts to increase the number of responses is focusing on Northern tier states and will continue in the next quarter.

Survey 3 was distributed to Michigan regional bridge managers and bridge maintenance personnel about unscheduled urgent activities and the causes of these activities. Details of unscheduled actions from the Bridge Management System were provided by MDOT and are supplementing the information from Survey 3.

A draft version of Survey 2 has been prepared and is being finalized by the research team. Like Survey 3, it will be directed to Michigan regional bridge managers and bridge maintenance personnel to identify which of the bridge preservation treatments they use, at what expected timing, and with what construction duration. They will also respond to the type of traffic control they would expect to use. The survey is an excel spreadsheet and includes drop down lists of responses to speed completing the surveys.

The Literature review has been revised to use the same terminology as was used in the Michigan Bridge Preservation Partnership (MBPP) survey. This terminology, with the addition of a few items from Michigan's list of treatments, was used in Survey 1 and will be used in Survey 2. The work on the revised literature review will continue as the project progresses.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The research team completed Survey 1, focusing on states with climates like Michigan's climate.

Survey 2 was distributed to regional bridge managers and bridge maintenance engineers in Michigan DOT.

Surveys were checked for consistency and completeness. A summary of both surveys was provided to the Research Advisory Panel.

Work on the literature review continued and the initial chapters of the final report were written in draft form.

Mobility impacts of typical MDOT preservation activities were reported from the survey data.

Mobility impact costs due to traffic delays were quantified

The costs of various preservation activities were compiled.

Work began on a life cycle cost tool to evaluate the long-term programmatic impacts of multiple preservation interventions as compared to the impact of emergency maintenance actions, bridge replacements and heavy maintenance.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Revise final report based on comments. Revise analysis for the user delay costs and life cycle cost tool. Prepare a training webinar for MDOT bridge staff. Submit final report.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

A change of Project Manager (PM) was approved on 10/19/2018. Eric Burns replaced Rebecca Curtis.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2020.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Research on the Operational Costs and Benefits of Speed Feedback Signs			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (<i>PLEASE EXPLAIN</i>)			
PROJECT MANAGER: Alonso Uzcategui			
CONTRACT/AUTHORIZATION NO.	2018-0045	PROJECT START DATE	7/1/2018
PROJECT NO.	201399	COMPLETION DATE (Original)	6/30/2020
OR NO.	OR17-204	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University		
PRINCIPAL INVESTIGATOR	Timothy Gates, Ph.D., P.E.		
BUDGET STATUS			
FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$114,025.30	Total Vendor Budget	\$200,704.74
MDOT Budget FY 2019	\$12,500.00	Total MDOT Budget	\$12,000.00
Vendor FY 2019 Expenditures	\$41,919.92	Total Budget	\$212,704.74
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$42,048.81
		Total Amount Available	\$170,655.93
PURPOSE AND SCOPE			
<p>From 2011-2015, interchange ramps averaged over 40 fatal and severe injury crashes annually. Operationally, these crashes often result in long periods of closure with rerouted traffic impacting the transportation network and a number of secondary crashes. Interchange ramp Dynamic speed feedback signing (DSFS) offers the potential to reduce crashes. This installation alerts drivers exceeding the recommended speed with a flashing speed value. There is potential to enhance communications with operations centers, vehicle to infrastructure intelligent transportation systems (ITS), and vehicle to vehicle ITS. Existing research on dynamic speed feedback signs many provide information on how to approach these efforts.</p> <p>The goal of this research is to evaluate the effectiveness of sign technologies equipped with feedback systems versus traditional warning signs. The major task needed to achieve this goal include the following:</p> <ul style="list-style-type: none"> • Literature review and state of the practice survey of other states • Site selection • Identifying components • Recommending equipment for purchase • Procuring equipment for MDOT ownership. • Installing equipment • Testing and connecting equipment in lab setting • Field installation • Data Collection • Analysis of data • Recommendations and reporting 			
FISCAL YEAR 2018 ACCOMPLISHMENTS			
<p>The following tasks were completed:</p> <ul style="list-style-type: none"> • Literature Review • State Agency Survey 			
FISCAL YEAR 2019 ACCOMPLISHMENTS			
<p>The following tasks were initiated:</p> <ul style="list-style-type: none"> • Site Selection • Field Evaluation • Data Analysis 			
FISCAL YEAR 2020 PROPOSED ACTIVITIES			
Develop Guidance for using DSFS on interchange ramps and submit the Final Report with recommendations.			
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))			
None.			
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)			
Project expected completion FY 2020.			

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Reduction of pH Levels from Underdrain Outlets			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Harold Zweng			
CONTRACT/AUTHORIZATION NO.	2016-0065 Z4	PROJECT START DATE	5/1/2018
PROJECT NO.	201402	COMPLETION DATE (Original)	3/31/2020
OR NO.	OR17-205	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Lawrence Technological University		
PRINCIPAL INVESTIGATOR	Nishantha Bandara, Ph.D., P.E.		
BUDGET STATUS			
FY 2019 Expenditures		Total Budget	
Vendor Budget FY 2019	\$107,851.74	Total Vendor Budget	\$169,010.19
MDOT Budget FY 2019	\$13,000.00	Total MDOT Budget	\$0.00
Vendor FY 2019 Expenditures	\$60,550.63	Total Budget	\$169,010.19
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$68,918.52
		Total Amount Available	\$100,091.67
PURPOSE AND SCOPE			
<p>Effluent from some open graded underdrains has elevated pH and soluble minerals. Precipitate is found at under drain outlets. This sometimes enters the storm sewer system, which is considered an illicit discharge under MDOT's municipal separate storm sewer system (MS4) permit. MDOT has been monitoring water quality at about 10 locations throughout the state to confirm that this problem exists. The cause of the high pH and precipitate is believed, but not confirmed, to be from the fine dust contained in recycled crushed concrete used as a base material layer under the roadway. Perforated underdrain pipes are usually placed under the layer of crushed material to collect water and protect the roadway from damaging saturation and freezing conditions. Better understanding the water chemistry that leads to elevated pH and precipitate and best practices to address the problem would help MDOT improve water quality from existing outlets and future construction.</p> <p>The objectives of this project include the following:</p> <ol style="list-style-type: none"> 1. Investigate national research and best practices on this topic. 2. Determine sources and causes of the high pH, soluble particles, and precipitate. 3. Propose practical methods to reduce pH levels and soluble particles at current or future sites thereby meeting or attaining lower levels set forth in the MS4 permit. <p>The scope of work for this project includes the following tasks:</p> <ol style="list-style-type: none"> 1. Review available literature to determine national best practices. 2. Review relevant data collected by the State of Michigan. 3. Design a sampling and data collection program to augment existing data. 4. Analyze collected data from both a statistical and scientific perspective (i.e. water chemistry, geology). 5. Prepare reports and recommendations 			
FISCAL YEAR 2018 ACCOMPLISHMENTS			
<p>The Principal Investigator (PI) has completed a literature review, reviewed MDOT's outlet data, designed a preliminary sampling plan, and conducted some field sampling. The Advisory Panel has met with the PI and commented on additional literature that may be reviewed, as well as discussed sampling techniques and locations.</p>			
FISCAL YEAR 2019 ACCOMPLISHMENTS			
<p>Literature review and review of previous MDOT sampling results are generally complete at the end of FY 2019. Most of the field sampling has been conducted; however, the research team experienced difficulty finding enough suitable sites for sampling. To address this, they have proposed construction of a test apparatus to synthesize the process of water leaching through aggregate layers and into underdrain. The MDOT Research Advisory Panel (RAP) approved the test method and this sampling method has begun.</p>			
FISCAL YEAR 2020 PROPOSED ACTIVITIES			
<p>The research team will run the test apparatus long enough to collect meaningful data. The MDOT RAP will meet with the PI and team in January to determine if satisfactory progress has been made. Due to the rate at which the test can be run, it may be necessary to extend the project time to realize useful results.</p>			

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
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None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2020.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Sponsorship of the TRB Roundtable on Preparing for Automated Vehicles and Shared Mobility Services

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Andre Clover

CONTRACT/AUTHORIZATION NO.	N/A	PROJECT START DATE	10/1/2017
PROJECT NO.	203301	COMPLETION DATE (Original)	9/30/2019
OR NO.	OR18-016	COMPLETION DATE (Revised)	
RESEARCH AGENCY	National Academy of Sciences		
PRINCIPAL INVESTIGATOR	Director Kirk Steudle		

BUDGET STATUS

FY 2019 Budget		Total Budget	
TRB Invoiced:		Vendor Total Cost	\$50,000.00
Vendor FY 2019 Invoice Amt.	\$25,000.00	MDOT Total Budget	\$50,000.00
MDOT FY 2019 Expenditures	\$25,000.00	Total Expenditures	\$50,000.00
		Total Amount Available	\$0.00

PURPOSE AND SCOPE

The objective of this Forum is to bring together public, private and research organizational partners to discuss, identify, and facilitate fact-based research needed to deploy automated vehicles and shared mobility services in a manner and timeframe that informs policy to best meet long-term goals, and to share perspectives on these issues. The long-term goals include increasing safety, reducing congestion, enhancing accessibility, increasing sustainability, and encouraging economic development and equity.

National Academies' Forums are supported by financial contributions from sponsoring organizations. Annual dues levels for this forum are included in the table below. A two-year commitment is preferred but not required.

ENTITY	DUES AMOUNT
Federal/State Government	\$25,000
Private For-Profit	\$25,000
Universities / Non-Profit	\$8,000
Regional/Local Government	\$5,000

FISCAL YEAR 2018 ACCOMPLISHMENTS

Research needs have been generated from convening activities leading up to the formation of the Forum, including the TRB Symposium "Partners in Research – Transformational Technologies" held in 2016 and the scoping meeting for the Forum held in 2017. They have been further refined through a January 2018 survey of the organizations participating in the Forum, and an in-depth discussion as part of the February 2018 kick-off meeting of the Forum.

The forum also posed four overarching strategic questions for researchers and practitioners to address (10 Transportation Research Circular E-C236):

- What can we do to build awareness of the potential transformational impacts on society across a broader spectrum of people?
- What options exist to generate and fund a significant strategic research effort or program to inform policy decisions?
- How can we best leverage existing research programs to help address these issues?
- What new approaches to our conventional research process should we consider?

FISCAL YEAR 2019 ACCOMPLISHMENTS

During FY 2019, the four overarching strategic questions posed previously continue to be the focus of the Forum's fiscal year activities, along with informing members on a list of research needs. The Forum continued to refine the list of priority research questions and prepared research problem statements. Events include the 2019 TRB Annual Meeting, Winter 2019 TRB Automated Vehicles and Shared Mobility (AV/SM) Forum meeting and the 2019 Automated Symposium.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

- (1) Forum shared information of ongoing and recently completed research that assist in meeting long term policy goals.
- (2) Commissioned authored papers to inform the Forum and/or to provide perspectives on Forum current/future discussions.
- (3) Sponsored sessions at the annual TRB Automated Vehicle Symposium (AUVSI) and other appropriate venues to keep Forum sponsors and others up to date.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Evaluation of Camber and Deflections for Bridge Girders			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Kyle Kopper			
CONTRACT/AUTHORIZATION NO.	2016-0070 Z7	PROJECT START DATE	3/1/2019
PROJECT NO.	204643	COMPLETION DATE (Original)	3/31/2021
OR NO.	19-002	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Wayne State University		
PRINCIPAL INVESTIGATOR	Fatmir Menkulasi		
BUDGET STATUS			
FY 2019 Budget		Total Budget	
Vendor Budget FY 2019	\$111,027.32	Total Vendor Budget	\$301,025.84
MDOT Budget FY 2019	\$5,600.00	Total MDOT Budget	\$14,400.00
Vendor FY 2019 Expenditures	\$77,837.12	Total Budget	\$315,425.84
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$77,837.12
		Total Amount Available	\$237,588.72
PURPOSE AND SCOPE			
<p>Two factors that can significantly impact ride quality over bridges are the camber and deflection of the beams. In addition to their impact on ride quality, cambers and deflections different than those estimated during design can lead to the need for changes during the construction of the project, which can result in increased cost and longer construction durations.</p> <p>MDOT currently utilizes time tested empirical equations to determine camber and long-term deflections for prestressed beams. However, due to ever changing design strengths and concrete mixes, there is a need to re-evaluate these equations based on values for camber and deflection measured during current and future bridge construction projects, and accounting for current fabrication practices.</p> <p>To achieve this objective the scope of work for this research project, tasks will include developing the following:</p> <ol style="list-style-type: none"> 1. An understanding of applicable research and current state of practice of other DOT's. 2. Procedures for accurately predicting camber for prestressed concrete beams. 3. Procedures for accurately predicting rebound for existing beams during deck replacement. 4. Procedures for accurately predicting deflections at all stages of construction for all beam types, existing and new. 5. Guidelines for calculating slab and screed elevations, both on the bridge and along the structural approach slabs, based on the findings of the research. 			
FISCAL YEAR 2019 ACCOMPLISHMENTS			
<p>Tasks completed during Fiscal Year 2019 include:</p> <ol style="list-style-type: none"> 1. Conducting a literature review of the current state of the practice related to estimating camber and deflection. 2. Evaluating camber and deflection data collected from MDOT bridge construction projects. 3. Identifying and evaluating the impact of the different factors that affect prestressed concrete beam camber. 4. Conducting a survey of other State DOTs to determine what their current practice is related to estimating camber and deflections, fabricating prestressed concrete beams, and about issues related to camber and deflection that they have encountered. 			
FISCAL YEAR 2020 PROPOSED ACTIVITIES			
<p>Tasks anticipated to be completed Fiscal Year 2020 include:</p> <ol style="list-style-type: none"> 1. Identifying and evaluating the impact of the different factors that affect composite steel and concrete member deflections. 2. Identifying and evaluating the impact of the different factors that affect existing steel and concrete members when new loads are applied. 3. Developing design procedures for estimating camber and deflection based on the research done as part of this project. 4. Completing laboratory testing to measure specific properties of concrete used in the fabrication of prestressed concrete beams using MDOT specifications. This includes the modulus of elasticity, creep factors, and shrinkage factors. 			
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))			
None.			
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)			
Expected completion FY 2021.			

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Concrete Deterioration of Prestressed Bridge Beams			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Jonathan Bruinsma			
CONTRACT/AUTHORIZATION NO.	2016-0069 Z9	PROJECT START DATE	3/1/2019
PROJECT NO.	204644	COMPLETION DATE (Original)	2/28/2021
OR NO.	19-017	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Western Michigan University		
PRINCIPAL INVESTIGATOR	Upul Attanayake		
BUDGET STATUS			
FY 2019 Budget		Total Budget	
Vendor Budget FY 2019	\$113,285.11	Total Vendor Budget	\$257,306.84
MDOT Budget FY 2019	\$2,187.50	Total MDOT Budget	\$5,312.50
Vendor FY 2019 Expenditures	\$31,893.97	Total Budget	\$262,619.34
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$31,893.97
		Total Amount Available	\$230,725.37
PURPOSE AND SCOPE			
<p>Many prestressed concrete beam bridges in Michigan constructed in the 1970's and 1980's exhibit mild to significant concrete deterioration due to Alkali Aggregate Reactivity (AAR). The primary material compatibility issue lies with Alkali Silica Reactivity (ASR), though Alkali Carbonate Reactivity (ACR) is also of concern. Deterioration due to AAR has necessitated premature repairs on a number of bridges – including, in some cases, full superstructure replacements. It is currently unknown how widespread this problem is in Michigan bridges and whether bridges built in the 1990's and beyond are also susceptible to deterioration due to AAR. As part of this research project, WMU will investigate the following six (6) tasks:</p> <ol style="list-style-type: none"> (1) The status of MDOTs bridge inventory and condition with respect to AAR (2) Effects of AAR on the capacity of prestressed concrete beams (3) Guidelines for load rating given the presence of AAR (4) Options for field testing for AAR (5) Rehabilitation options for prestressed concrete beams with AAR (6) Guidelines for bridge inspectors for both National Bridge Inventory (NBI) component ratings and AASHTO National Bridge Element ratings in alignment with the Michigan Structure Inspection Manual (MiSIM) and Michigan Bridge Element Inspection Manual 			
FISCAL YEAR 2019 ACCOMPLISHMENTS			
Task 1 Accomplishments:			
<ul style="list-style-type: none"> • Developed and administered a survey of Region Bridge Engineers to help determine the extent of cracking on MDOT-owned prestressed concrete (PC) beam bridges • Prepared a list of NBI and Structure Inventory & Analysis (SIA) element data needed for inventory analysis. <ul style="list-style-type: none"> ◦ Analyzed this list as well as inspector comments ◦ Distress charts were developed based on analysis of inspector comments on SIA reports to identify clusters of bridges with distress types that indicate specific concrete deterioration mechanisms • Survey of PC girder fabrication inspectors and precast plant staff was administered. • Two precast plants were visited to document girder end distress types and plant experience • Inspection templates developed for field review of bridges with suspected ASR in PC girders • Field reviews performed on multiple University Region bridges with PC girders 			
Task 4 Accomplishments:			
<ul style="list-style-type: none"> • Uranyl acetate testing method was used to benchmark assessment procedures • Data collected using Raman Spectroscopy testing method to evaluate the possibility of using such advanced technologies for detecting ASR 			
Task 5 Accomplishments:			
<ul style="list-style-type: none"> • Literature review of guidelines and best practices of various agencies • Products from MDOT's Qualified Products List (QPL) were reviewed • Application methods, effectiveness, and challenges of such methods were documented 			

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Task 1 Activities:

- Further analysis of inspector comments to determine the extent of concrete deterioration due to ASR in MDOT bridges
- Field reviews to verify findings

Task 2 Activities:

- Develop finite element models to evaluate the effects of longitudinal cracks due to ASR on the stress/strain distribution and subsequent load capacity of PC girders

Task 3 Activities:

- Using the finite element models developed as part of Task 2, develop load rating guidelines for PC girders affected by ASR in alignment with the Michigan Bridge Analysis Guide

Task 4 Activities:

- Further evaluation of field methods for testing for ASR

Task 5 Activities:

- Review the performance and advantages/drawbacks of using typical products as well as proprietary innovative products available in the market
- Develop an experimental program for assessing such products for mitigating or controlling ASR

Task 6 Activities:

- Develop rating guidelines for bridge inspectors for both NBI component and AASHTO element rating systems

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
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None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2021.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Training Tools for Effective Advancement of Digital Technologies for Construction Field Operations			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (<i>PLEASE EXPLAIN</i>)			
PROJECT MANAGER: Matthew Bellgowan			
CONTRACT/AUTHORIZATION NO.	TBD	PROJECT START DATE	2/1/2020
PROJECT NO.	204646	COMPLETION DATE (Original)	4/30/2022
OR NO.	OR19-133	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University		
PRINCIPAL INVESTIGATOR	Mohamed El-Gafy, Ph.D., P.E.		
BUDGET STATUS			
FY 2019 Budget		Total Budget	
Vendor Budget FY 2019	\$75,000.00	Total Vendor Budget	\$213,037.24
MDOT Budget FY 2019	\$5,000.00	Total MDOT Budget	\$28,440.00
Vendor FY 2019 Expenditures	\$0.00	Total Budget	\$241,477.24
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$0.00
		Total Amount Available	\$241,477.24
PURPOSE AND SCOPE			
<p>Simple and effective training tools are needed to increase the knowledge base of construction field staff to support sustainable construction field operation practices. Core competency development with software and hardware technologies is necessary to realize the benefits of digital technology. Engineer and technical field staff skillsets vary widely in preparation for use of these technologies and practices. Training opportunities are often restricted to on-the-job learning and growth potential through exposure and learning with consultant staff field support, thus bridging knowledge gaps. Construction field staff training typically lags in comparison to the contracting and consultant industries. Training in the field or on-the-job has not been sustainable as opportunities to use knowledge gained year to year creates a population of construction field staff with varying levels of proficiency which in turn yields limited project management consistency and alignment within the Michigan Department of Transportation. Staff should have exposure to digital technologies as the standard for construction field operations through education and training.</p>			
FISCAL YEAR 2019 ACCOMPLISHMENTS			
Contract authorization was delayed until Fiscal Year 2020. This Fiscal Year, proposals received were scored and the selected research organization was announced.			
FISCAL YEAR 2020 PROPOSED ACTIVITIES			
The first year of the project will focus on data collection and analysis. This phase will explore the need analysis, target audience analysis and task and topic analysis, and allow for an assessment of MDOT construction field operations work force knowledge and experience in the areas of 3D technology, project PDFs and assets management.			
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))			
None.			
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)			
Expected project completion Fiscal Year 2020.			

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Improved Calculation of Scour Potential in Cohesive Soils and Scour Susceptible Rock

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Beckie Curtis

CONTRACT/AUTHORIZATION NO.	2016-0067 Z8	PROJECT START DATE	5/1/2019
PROJECT NO.	204647	COMPLETION DATE (Original)	6/30/2020
OR NO.	19-132	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan Technological University		
PRINCIPAL INVESTIGATOR	Zhen Liu		

BUDGET STATUS

FY 2019 Budget		Total Budget	
Vendor Budget FY 2019	\$89,417.82	Total Vendor Budget	\$90,417.82
MDOT Budget FY 2019	\$12,100.00	Total MDOT Budget	\$14,500.00
Vendor FY 2019 Expenditures	\$25,047.40	Total Budget	\$104,917.82
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$25,047.50
		Total Amount Available	\$79,870.42

PURPOSE AND SCOPE

Scour in cohesive soils and rock has been a challenge for engineers in designing safe, yet cost-effective new bridges with these site characteristics. Also, many existing bridges have been identified with a scour critical condition, which poses safety risks and requires additional resources for inspections. Unlike non-cohesive soils, standardized scour analysis methodologies and broadly accepted guidance on testing and then subsequent analysis of the scour susceptibility of cohesive soils and rock are lacking. Nationally, research has been conducted by various states and educational institutions related to this topic; however, this has not been accomplished within Michigan's unique environment at MDOT bridge sites. The scope of work includes the following tasks:

1. Review literature and state of the practice
2. Synthesize the existing information on cohesive soil and rock sampling techniques.
3. Evaluate and compare scour susceptibility testing techniques and applicable scour analysis approaches
4. Investigate all factors with the potential to affect the scour susceptibility of soil or rock
5. Report on findings including
 - a. A protocol for cohesive soil scour susceptibility testing and data evaluation.
 - b. A protocol for rock scour susceptibility testing and data evaluation.
 - c. Application of scour susceptibility testing to scour analysis.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The following tasks were initiated or completed in FY 2019

- Literature Review
- Interview of MDOT subject matter experts
- Interview of other State DOTs
- Map geology of Michigan

FISCAL YEAR 2020 PROPOSED ACTIVITIES

The following tasks 2 through 5 are proposed for the next fiscal year:

2. Synthesize the existing information on the following topics and their applicability in the Michigan geologic and hydraulic environment:
 - a. Cohesive soil sampling techniques and testing devices.
 - b. Rock sampling techniques and testing devices. For the purposes of this research, rock with scour concerns, or rock with a Rock Quality Designation (RDQ) less than 50 should be considered.
3. Evaluate and compare scour susceptibility testing techniques and applicable scour analysis approaches presented in the current Hydraulic Engineering Circular (HEC) 18 publication for many bridge sites from each geologically or hydrologically unique region of Michigan. For the purposes of this research, rock for testing will be rock with scour concerns, or rock with an RDQ less than 50. Comparisons must also be made to traditional non-cohesive soil scour analysis procedures. Summarize the geology factors relevant to the problem. Get approval from Research Advisory Panel (RAP) on progress before continuing to step 4.
4. Investigate all factors with the potential to affect the scour susceptibility of soil or rock to determine applicable characteristics including (but not limited to) wetting and drying cycles, freeze-thaw, abrasion and chemical reactions. Define parameters to quantify future erosion based on multiple flooding events over the life of a structure. Perform a sensitivity analysis of any knowledge gaps. Recommend a Michigan rock classification system that identifies typical types of rock as foundationally stable while accounting for relevant physical and climatic conditions. Get approval from RAP before continuing to task 5.

-
5. Report on findings. (MDOT may choose to initiate an additional research phase based on findings). Report should include an outline for the scope of potential research projects that will address Michigan's areas of uncertainty such as:
- a. A protocol for cohesive soil scour susceptibility testing and data evaluation.
 - b. A protocol for rock scour susceptibility testing and data evaluation.
 - c. Application of scour susceptibility testing to scour analysis.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Expected project completion FY 2020.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Development of a Network-level Evaluation Tool for Managing ITS Infrastructure			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Joseph Gorman			
CONTRACT/AUTHORIZATION NO.	2019-0377	PROJECT START DATE	5/1/2019
PROJECT NO.	204648	COMPLETION DATE (Original)	6/30/2021
OR NO.	19-052	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Cambridge Systematics		
PRINCIPAL INVESTIGATOR	Samuel C. Van Hecke		
BUDGET STATUS			
FY 2019 Budget		Total Budget	
Vendor Budget FY 2019	\$91,141.26	Total Vendor Budget	\$473,934.56
MDOT Budget FY 2019	\$2,692.31	Total MDOT Budget	\$11,307.69
Vendor FY 2019 Expenditures	\$42,581.69	Total Budget	\$485,242.25
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$42,581.69
		Total Amount Available	\$442,660.56
PURPOSE AND SCOPE			
<p>The purpose of this project is to evaluate Intelligent Transportation Systems (ITS) network performance and develop and deliver a user-friendly performance evaluation tool for use on existing or proposed ITS programs. The project includes: Development of a vision for the tool; compilation of the existing ITS inventory and relevant roadway performance data; defining the limits of the network; evaluating current ITS performance; identifying gaps in ITS coverage and density; development of the performance evaluation tool; development of a tool implementation and training strategy; and documentation of research in a final report.</p>			
FISCAL YEAR 2019 ACCOMPLISHMENTS			
<p>Held project kickoff meeting with the Research Advisory Panel (RAP). Also held a project visioning session where a draft and final vision were created. Began compilation of existing ITS inventory and relevant roadway performance data and defining the limits of the network.</p>			
FISCAL YEAR 2020 PROPOSED ACTIVITIES			
<p>Continue progress meetings with the RAP. Complete compilation of existing ITS inventory and relevant roadway performance data and defining the limits of the network. Complete evaluation of current ITS performance and start identifying gaps in ITS coverage and density. Begin development of the performance evaluation tool.</p>			
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))			
<p>A change in project manager from Brandan Maurer to Joseph Gorman was approved on 9/15/2019.</p>			
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)			
<p>Project expected completion FY 2021.</p>			

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Recruit and Maintain/Upgrade a High-Tech Workforce for Emerging Technologies			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (<i>PLEASE EXPLAIN</i>)			
PROJECT MANAGER: Elise Feldpausch			
CONTRACT/AUTHORIZATION NO.	2019-1038	PROJECT START DATE	10/15/2019
PROJECT NO.	204651	COMPLETION DATE (Original)	6/30/2021
OR NO.	OR19-129	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Center for Automotive Research		
PRINCIPAL INVESTIGATOR			
BUDGET STATUS			
FY 2019 Budget		Total Budget	
Vendor Budget FY 2019	\$226,667.00	Total Vendor Budget	\$253,065.27
MDOT Budget FY 2019	\$16,750.00	Total MDOT Budget	\$25,000.00
Vendor FY 2019 Expenditures	\$0.00	Total Budget	\$278,065.27
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$0.00
		Total Amount Available	\$278,065.27
PURPOSE AND SCOPE			
The construction and operations of transportation-related infrastructure is poised to undergo a dramatic shift due to rapidly emerging technologies in the next ten years. This shift will expose work force to these emerging technologies that are either already filtering in or will rapidly impact the industry soon. Upgraded training is necessary to ensure that the work force is ready for the technological shift. It will be critical to identify the attributes and impacts of emerging technologies that will require a differently trained work force for construction and operations of transportation-related infrastructure.			
FISCAL YEAR 2019 ACCOMPLISHMENTS			
The contract was delayed from Fiscal Year 2019 to Fiscal Year 2020. Proposals received were scored, the selected research organization was announced, and the contracting process was started.			
FISCAL YEAR 2020 PROPOSED ACTIVITIES			
The contract was authorized to start in Fiscal Year 2020. This year, a state of practice review for transformative technologies will be completed and a recommendation for ideal core competencies and organization structure will be created.			
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))			
None.			
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)			
Expected project completion Fiscal Year 2021.			

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Effectiveness of Green Strobes on Winter Maintenance Vehicles and Equipment				
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)				
PROJECT MANAGER: Jim Gaus and Melissa Longworth				
CONTRACT/AUTHORIZATION NO.	2019-0442		PROJECT START DATE	6/4/2019
PROJECT NO.	204652		COMPLETION DATE (Original)	5/31/2020
OR NO.	19-127		COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University			
PRINCIPAL INVESTIGATOR	Ali Zockaie			
BUDGET STATUS				
FY 2019 Budget			Total Budget	
Vendor Budget FY 2019	\$92,760.10		Total Vendor Budget	\$110,860.03
MDOT Budget FY 2019	\$13,800.00		Total MDOT Budget	\$13,800.00
Vendor FY 2019 Expenditures	\$28,415.75		Total Budget	\$124,660.03
MDOT FY 2019 Expenditures	\$0.00		Total Expenditures	\$28,415.75
			Total Amount Available	\$96,244.28
PURPOSE AND SCOPE				
The research project's purpose is to confirm or refute the effectiveness of green auxiliary warning lights, with or without amber, on winter maintenance equipment. This will include a review of flash patterns.				
FISCAL YEAR 2019 ACCOMPLISHMENTS				
Completed the literature review, reviewed current practices and crash data, and designed experiments for static and dynamic tests.				
FISCAL YEAR 2020 PROPOSED ACTIVITIES				
Release survey to other agencies for information on auxiliary warning light use, conduct static and dynamic tests of various light configurations, and provide report of research results.				
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))				
None.				
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)				
Project completion expected FY 2020.				

RESEARCH ADMINISTRATION MDOT RESEARCH PROJECT ANNUAL REPORT - FISCAL YEAR 2019

PROJECT TITLE: Integration of Unmanned Aerial Systems Data Collection in Day-to-Day Usage for Transportation Infrastructure

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Steve Cook

CONTRACT/AUTHORIZATION NO.	2019-0311 Z1	PROJECT START DATE	6/12/2019
PROJECT NO.	204653	COMPLETION DATE (Original)	6/11/2022
OR NO.	19-064	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan Technological University		
PRINCIPAL INVESTIGATOR	Collin Brooks		

BUDGET STATUS

FY 2019 Budget		Total Budget	
Vendor Budget FY 2019	\$151,480.00	Total Vendor Budget	\$871,003.00
MDOT Budget FY 2019	\$4,444.44	Total MDOT Budget	\$35,555.55
Vendor FY 2019 Expenditures	\$101,986.00	Total Budget	\$906,558.55
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$101,986.00
		Total Amount Available	\$804,572.55

PURPOSE AND SCOPE

Based on Unmanned Aerial Systems (UAS) data collection, develop workflows to implement applications into regular use that will meet the Department's needs for timely, high-resolution, safely collected, repeatable, and objective data. Make these data, applications, and workflows part of day-to-day usage for management and operations (planning, design, construction, operations, maintenance, asset management, etc.), especially under new federal rules that are increasing the practical deployment of UAS. Enable leveraging these rapidly advancing technologies to meet operational data needs for connected vehicle corridor surveillance, construction site monitoring, asset management, traffic monitoring, geophysical evaluations, incident management, infrastructure inspection (e.g., bridges, roads, railways, etc.), confined space safety assessment, and pro-active monitoring of roadways and bridges, among other applications.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Fieldwork was conducted along I-96 Eastbound in Lansing to collect bridge inspection, traffic monitoring, and construction inspection data and work with MDOT SMEs and other staff.

- Collected data on four bridges and one corridor segment, including one bridge undergoing construction repair of joints.
- Collected 10+ hours of traffic data along I-96 west bound and at nearby intersections, including detour areas of interest to construction SME Jason Early.
- Demonstrated using small quadcopter with obstacle avoidance to capture imagery from under bridges.

Performed initial training on the Bergen Hexacopter to MDOT Aeronautics staff.

Fieldwork conducted on an I-69 bridge near Lansing to demonstrate bridge inspection with multiple drone platforms including use of the Flyability Elios for difficult-to-access area imaging.

Began communications with MDOT SME's on Traffic Operations (Milestone 1), Bridge Inspections (Milestone 2), Construction Inspection (Milestone 3), and LiDAR UAS for Design Survey (Milestone 4) to plan future fieldwork, training, and other implementation activities.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Continue training activities with MDOT Aeronautics.

Continue planning on fieldwork activities with Jason Early for construction use case.

Continue investigation of methods for element bridge level inspection and near real-time distribution of traffic video and analysis methods.

Perform LiDAR data collection for Use Case 4.

Select equipment-level drone (currently recommending the MD4-1000 \$27k system).

Continue documentation needed for project wrap-up and reporting.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2022.

RESEARCH ADMINISTRATION MDOT RESEARCH PROJECT ANNUAL REPORT - FISCAL YEAR 2019

PROJECT TITLE: Synthesis of National Best Practices on Pedestrians and Bicycle Design, Guidance and Technology Innovations

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Carissa McQuiston

CONTRACT/AUTHORIZATION NO.	2019-0369	PROJECT START DATE	4/1/2019
PROJECT NO.	204654	COMPLETION DATE (Original)	9/30/2020
OR NO.	19-072	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University (MSU)		
PRINCIPAL INVESTIGATOR	Timothy Gates		

BUDGET STATUS

FY 2019 Budget		Total Budget	
Vendor Budget FY 2019	\$157,685.21	Total Vendor Budget	\$206,101.91
MDOT Budget FY 2019	\$7,300.00	Total MDOT Budget	\$7,300.00
Vendor FY 2019 Expenditures	\$9,878.06	Total Budget	\$213,401.91
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$9,878.06
		Total Amount Available	\$203,523.85

PURPOSE AND SCOPE

This synthesis is a comprehensive review of the Department's scoping and design guidance, along with a comparison of national efforts and best practices supporting active transportation to accelerate our efforts. This review is to be followed by recommendations related to traffic signing, traffic signal, and operational technologies to minimize excessive delays or detours and improve roadway crossings for pedestrians and bicyclists. Additionally, recommendations on geometric design changes that can improve user visibility, improving access, safety and mobility for people who travel on foot or by bicycle, should be considered. The project scope includes the following tasks:

- Identify best practices nationally or internationally.
- Review current MDOT best practices and all research available currently.
- Review lessons learned from other cities, state, etc. on processes they utilized and implementation.
- Review Americans with Disabilities Act (ADA) compliance and innovations.
- Develop/update best practices.
- Broaden scoping and design review to consider additional elements related to bike/pedestrian.
- Provide recommendations within MDOT scoping/design processes.
- Provide technical assistance to the Multimodal Development and Delivery (M2D2) process.
- Develop materials to promote bike/pedestrian importance within MDOT.

FISCAL YEAR 2019 ACCOMPLISHMENTS

- Identify Best Practices: A synthesis of the reviewed literature is ongoing. All pertinent references have been collected (400-500 total) and have been synthesized in a best practices document and summarized in appendices. This document is under internal review.
- Review Current MDOT Practices: Several M2D2 documents are currently unavailable and, thus, not ready for review by the MSU team. MSU has reviewed and provided comments on the DRAFT crosswalk guidance sent to the team by Carissa McQuiston. Other relevant documents are being reviewed.
- Examine Lessons Learned from Other Cities and States: A review of lessons learned from other cities and states is ongoing and a synthesis document has been prepared. This document is under internal review.
- Conduct Interviews of Stakeholder Groups: MSU is developing a "State of the State" survey they believe will be an appropriate instrument to obtain necessary statewide sampling of stakeholder opinion to consider additional elements related to bike/pedestrian. A draft set of questions was circulated at the kickoff meeting and feedback has been received back from MDOT. The research team has corroborated this feedback and is in the process of modifying the survey for distribution. This will include three separate surveys for advocacy groups, agencies, and public opinion. Advocacy groups and public agencies have been identified for distribution.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

- Identify Best Practices: A synthesis of the reviewed literature will be completed and the review of the best practices document will be completed.
- Review Current MDOT Practices will be completed.
- Examine Lessons Learned from Other Cities and States: A review of lessons learned from other cities and states and the synthesis document will be completed.
- Review ADA Compliance with Innovations
- Conduct Interviews of Stakeholder Groups: the survey for the three stakeholder groups will be finalized, distributed and the results reviewed.

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- Develop and Update Best Practices
 - Provide Assistance to M2D2 process
 - Develop Materials to Promote Pedestrian/Bicyclist Issues
 - Prepare Final Project Report and Other Deliverables

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Expected project end FY 2020.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Evaluating the Impacts of the 2017 Legislative Mandated Speed Limit Increases

FUNDING SOURCE: ☒ SPR, Part II ☐ OTHER (PLEASE EXPLAIN)

PROJECT MANAGER: Mark Bott

CONTRACT/AUTHORIZATION NO.	2019-0275	PROJECT START DATE	3/1/2019
PROJECT NO.	204655	COMPLETION DATE (Original)	2/28/2022
OR NO.	19-107	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University		
PRINCIPAL INVESTIGATOR	Peter T. Savolainen		

BUDGET STATUS

FY 2019 Budget		Total Budget	
Vendor Budget FY 2019	\$79,765.47	Total Vendor Budget	\$230,104.19
MDOT Budget FY 2019	\$1,944.44	Total MDOT Budget	\$8,055.56
Vendor FY 2019 Expenditures	\$21,152.37	Total Budget	\$238,159.75
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$21,152.37
		Total Amount Available	\$217,007.38

PURPOSE AND SCOPE

In 2017, the Michigan legislature passed legislation requiring speed limits to be increased to 75 mph on 600 miles of trunkline freeways and 65 mph on 900 miles of trunkline non-freeways. In addition, the truck speed was raised to 65 mph on all freeways posted 65 mph or higher. Since the early stages of these legislative speed limit policy discussions, MDOT has initiated several research projects to quantify the safety, operational, and economic impacts associated with speed limit increases. According to a recently released report by (NHTSA), speeding is considered one of the major contributing factors to traffic crashes. In 2016, there were 31,722 speed related crashes in Michigan, with 192 of them being fatal. Existing studies that evaluated the impact of speed limit changes on non-freeways/freeways have found a positive association of changes in crash severity/frequency with changes in posted speed limit. The purpose of this research is to evaluate if the conclusions regarding crashes and an increase in operating speed in response to an increase in posted speed limits are still valid today on freeways and establish a conclusion regarding non-freeways and trucks. The research tasks include the following:

1. Survey of results and studies from other states
2. Speed and crash data collection
3. Determination of influencing factors associated with driver speed selection
4. Crash, operations/speed and cost analysis for trunkline network both effected and not effected by speed limit change
5. Evaluation of MDOT's selection process for routes to raise posted speed limit
6. Determine societal response to speed limit changes
7. Develop regional safety, operational and cost risk models development
8. Develop Project Report and Research Presentations

FISCAL YEAR 2019 ACCOMPLISHMENTS

Task 1 Survey of Results and Studies of Other States

The research team reviewed recent literature related to speed limits and the relationship between speed and safety. This information is being used to supplement the existing content that has been reviewed as a part of prior studies.

Task 2 Data Collection

MSU has assembled an existing database with crash, speed, and roadway inventory data. Field data collection was conducted throughout the summer of 2019. The team has obtained available data from the Road Asset Inventory (RAI), in addition to traffic volume data from MDOT. The team has also obtained the 2018 year-end crash data extract from the Michigan State Police. These data are currently being integrated for analysis purposes.

Task 3 Determination of Influencing Factors Associated with Driver Speed Selection

Speed data analyzed at an aggregate level. In general, speed increase of between 1 and 3 mph have occurred at most locations where increases have occurred. Similar data for control sites has largely remained unchanged. The research team is in the process of compiling pertinent roadway geometry and traffic volume data to allow for a detailed assessment of changes in operating speeds that have resulted since the speed limit increases.

Task 4 Crash, Operations/Speed, and Cost Analysis for Trunkline Network

Aggregate-level crash trends were compared between 2018 and the years immediately preceding the speed limit increase. In general, crashes, injuries, and fatalities have increased.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Task 5 Evaluate MDOT's Selection Process for Routes to Raise Posted Speed Limit Task 6 Determine Societal Response to Speed Limit Changes Task 7 Regional Risk Models Development Task 8 Develop Project Report and Research Presentations

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
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None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Project expected completion FY 2022.

RESEARCH ADMINISTRATION MDOT RESEARCH PROJECT ANNUAL REPORT - FISCAL YEAR 2019

PROJECT TITLE: Performance and Safety of the US-23 Flex Route			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Jason Firman			
CONTRACT/AUTHORIZATION NO.	2019-0289	PROJECT START DATE	3/1/2019
PROJECT NO.	204656	COMPLETION DATE (Original)	11/30/2022
OR NO.	19-114	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University		
PRINCIPAL INVESTIGATOR	Eva Kassens Noor		

BUDGET STATUS			
FY 2019 Budget		Total Budget	
Vendor Budget FY 2019	\$53,766.07	Total Vendor Budget	\$184,675.91
MDOT Budget FY 2019	\$3,181.82	Total MDOT Budget	\$11,818.19
Vendor FY 2019 Expenditures	\$20,211.91	Total Budget	\$196,494.10
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$20,211.91
		Total Amount Available	\$176,282.19

PURPOSE AND SCOPE

MDOT has built its first Flex Route, which is intended to reduce congestion and improve safety. It includes actively managing lanes of traffic and temporarily using the inside shoulder lane during peaks or other times when traffic is backed up due to incidents or other events. MDOT needs to understand what the performance and safety impacts of the Flex Route are. MDOT needs to understand how the traveling public is responding to the Flex Route and following the directions provided. Many improvements were made to US-23 that were not related to the Flex Route and MDOT would need to reasonably understand which changes were attributable to the Flex Route. The Flex Route increases capacity and could impact traffic downstream and MDOT needs to understand if it did and to what degree. The Flex Route also has some unique challenges for enforcement agencies which need to be identified for possible adjustments in the future. The scope of the research project includes the following tasks:

1. Quantify various changes in performance of traffic during peak and non-peak times. (Travel times, delays, reliability, etc.)
2. Evaluate the safety impacts when shoulder lane is and is not in operation
3. Determine how much of the traffic performance/safety changes were due to the Flex Route vs. other improvements of the roadway, for example ramp acceleration lane improvements.
4. Survey drivers of the Flex Route to determine their understanding how to drive the Flex Route and how it changed their driving habits and if they felt it improved their driving experience.
5. Determine the compliance rate when the temporary shoulder is not open.
6. Determine the effectiveness of the Flex Route during an incident within its limits which includes operating the temporary shoulder lane and crash investigation sites.
7. Evaluate the cost/benefit of the Flex Route. Include but is not limited to construction costs, maintenance, software upgrades, additional personnel.
8. Determine the effects of traffic upstream/downstream of the Flex Route on US-23 and M-14.
9. Determine what challenges and successes were seen by enforcement agencies.
10. Develop best practices (planning, design, operations, maintenance, public relations) of the Flex Route for potential additions to other freeways in Michigan.

FISCAL YEAR 2019 ACCOMPLISHMENTS

In 2019, the research team completed and submitted the Literature Review on Flex Routes (*Deliverable 1*).

Task 1 (quantify changes in performance of traffic), *Task 2* (evaluate the safety impacts), *Task 3* (Flex Route vs. other improvements), and *Task 5* (determine the compliance rate) have been conducted.

The research team has reviewed MDOT data, addressed arising questions jointly with Research Advisory Panel (RAP) members, and received requested operational data from the Active Traffic Management (ATM), Microwave Vehicle Detective System (MVDS), and Freeway Courtesy Patrol (FCP) databases.

The research team has identified trends before and during the flex route implementation including but not limited to performance (*Task 1*), crashes (*Task 2*) including taper areas, bottleneck dynamics (*Task 3*), and speed and lane violations (*Task 5*).

The driver survey (*Task 4*) has been designed and mailed three times to residents living in counties adjacent as well as upstream

and downstream of the US-23 Flex route.

The research team provided a very rough high-level, but quick, analysis of public perceptions (RAP in early September).

The research team has also analyzed incident management on US-23, including clearance times, paying particular attention to the change in vendors (*Task 6*).

The research team has held and analyzed three focus groups (*Task 9*) in Whitmore Lake: Brighton, and for First Responders:

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Results on the focus groups (*Task 9*) will be presented during January RAP meeting while *Task 9* will be completed slightly ahead of time.

The research team will analyze the responses from the driver survey and submit the report (*Deliverable 2*) as scheduled by March 1, 2020. Around the same times, the research team will provide the analysis of queue warning performance (*Deliverable 3*) that reviews (*Task 6*) incidents, vehicle breakdowns, and other FCP.

The driver compliance report (*Deliverable 4*) is scheduled to be submitted by June 1 primarily relaying results from *Task 5* on speed and lane utilization. The report will be supplemented by results from the Driver Survey (*Task 4*) and focus group results from (*Task 9*).

The research team will start focusing on (*Task 8*) to assess the effects of traffic upstream and downstream.

In late 2020, the research team will start the cost-benefit analysis (*Task 7*) and start drafting the best practice manual (*Task 10*).

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Expected project completion FY 2023.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Effectiveness of Crash Fact / Safety Message Signs on Dynamic Message Signs			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: Mark Bott			
CONTRACT/AUTHORIZATION NO.	2019-0295	PROJECT START DATE	3/15/2019
PROJECT NO.	204657	COMPLETION DATE (Original)	4/15/2020
OR NO.	19-122	COMPLETION DATE (Revised)	
RESEARCH AGENCY	Michigan State University		
PRINCIPAL INVESTIGATOR	Peter T. Savolainen		
BUDGET STATUS			
FY 2019 Budget		Total Budget	
Vendor Budget FY 2019	\$109,399.32	Total Vendor Budget	\$127,023.50
MDOT Budget FY 2019	\$3,462.00	Total MDOT Budget	\$3,462.00
Vendor FY 2019 Expenditures	\$20,483.18	Total Budget	\$130,485.50
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$20,483.18
		Total Amount Available	\$110,002.32

PURPOSE AND SCOPE

Driver behavior is the main contributor to crashes. Studies show that more than 90 percent of fatal crashes are associated with driver behavior. While engineering solutions play a key role in mitigating crash causes, a focus on changing behaviors of road users is critical to reducing crash occurrence. Dynamic Message Signs (DMS) displaying fatality statistics/safety messages are intended to raise awareness and emphasize the importance of focused driving and minimize potential driver errors that may result in a traffic crash. In Michigan, such messages are used intermittently and on a specific region basis. Also, there is no known evidence beyond anecdotal whether displaying such messages helps in changing driver behaviors and ultimately reducing crashes. Why are various states utilizing messages when they acknowledged not having seen an immediate impact on the motoring public? Are such messages being placed with a goal of education first? There is a need to determine the appropriate measures of effectiveness of Crash Facts/Safety Messages displayed on DMS on crashes, driver behavior and the overall safety culture, and to determine how to implement such a communication tool in ways that maximizes its impact.

The objectives are to:

1. Determine the measures of effectiveness of Crash Fact/Safety Messages displayed on DMS on crashes, driver behavior and the safety culture.
2. Establish DMS implementation and deployment plan that maximizes the benefits of Crash Fact/Safety Messages

The scope of work includes the following tasks:

- Task 1 Literature Review of Safety Message Delivery
- Task 2 State Survey Regarding DMS Utilization
- Task 3 Public Input Survey Regarding Safety Message Delivery
- Task 4 Evaluate Impacts of Safety Messages on Media/Public
- Task 5 Evaluate Impact of Messaging on Crashes/Operating Speeds
- Task 6 Evaluate Surrogate Safety Measures through Pilot Testing
- Task 7 Prepare Project Report and Other Deliverables

FISCAL YEAR 2019 ACCOMPLISHMENTS

Task 1 Literature Review of Safety Message Delivery

Work for this task has been completed. A summary of the literature review will be provided to MDOT and included in the project report.

Task 2 State Survey Regarding DMS Utilization

The team has corresponded with Texas A&M Transportation Institute (TTI) regarding work being conducted as a part of Behavioral Traffic Safety Cooperative Research Program project BTS-02: *Guide for Behavioral Traffic Safety Messaging on Variable Message Signs*. As a similar survey is being conducted as a part of that project, MSU will obtain pertinent information directly from TTI from BTS-02 efforts to the extent that is possible.

Task 3 Public Input Survey Regarding Safety Message Delivery

MSU has reviewed all safety messages displayed in Michigan, including message content, time of display, and locations of display. The survey questionnaire was deployed as a part of the spring 2019 Michigan State of the State Survey (SOSS) administered by MSU. Partial results from the SOSS have been obtained (1000 responses) and full data are expected during the first quarter of fiscal year 2020.

Task 4 Evaluate Impacts of Safety Messages on Media/Public

MSU has finished analysis of public perception data related to safety messages. Results were presented at the research advisory panel meeting.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Task 2 State Survey Regarding DMS Utilization

Task 3 Public Input Survey Regarding Safety Message Delivery

Task 5 Evaluate Impact of Messaging on Crashes/Operating Speeds

Task 6 Evaluate Surrogate Safety Measures through Pilot Testing

Task 7 Prepare Project Report and Other Deliverables

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)

Expected project completion FY 2020.

**RESEARCH ADMINISTRATION
MDOT RESEARCH PROJECT
ANNUAL REPORT - FISCAL YEAR 2019**

PROJECT TITLE: Development of a Michigan Specific VISSIM Protocol for Submissions of VISSIM*			
FUNDING SOURCE: <input checked="" type="checkbox"/> SPR, Part II <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
PROJECT MANAGER: John Engle			
CONTRACT/AUTHORIZATION NO.	2019-0079	PROJECT START DATE	11/27/2018
PROJECT NO.	204658	COMPLETION DATE (Original)	09/30/2019
OR NO.	18-011	COMPLETION DATE (Revised)	12/31/2019
RESEARCH AGENCY	WSP Michigan Inc.		
PRINCIPAL INVESTIGATOR	Matthew Hill		
BUDGET STATUS			
FY 2019 Budget		Total Budget	
Vendor Budget FY 2019	\$152,504.32	Total Vendor Budget	\$152,504.32
MDOT Budget FY 2019	\$10,000.00	Total MDOT Budget	\$10,000.00
Vendor FY 2019 Expenditures	\$90,688.42	Total Budget	\$162,504.32
MDOT FY 2019 Expenditures	\$0.00	Total Expenditures	\$90,688.42
		Total Amount Available	\$71,815.90
PURPOSE AND SCOPE			
<p>The purpose of the project is to evaluate current nationwide best practices in VISSIM* modeling, and to develop a set of Michigan Specific protocols to guide and evaluate vendor VISSIM models. The scope involves research best practices and, from the research, the development of a final primary report that provides the protocol, method, and requirements for all VISSIM modeling. This document shall be prepared by the research team and submitted to MDOT for review, along with a secondary report that identifies the reasoning and justification used in the production of the primary report.</p> <p>*Verkehr In Städten – SIMulationsmodell (VISSIM) is German for "Traffic in cities – simulation model"</p>			
FISCAL YEAR 2019 ACCOMPLISHMENTS			
<p>In FY 2019, the research team explored the best practices of VISSIM modeling and protocols. This involved investigating several protocol manuals developed for other states. Upon completion of the investigation, the research team subsequently prepared a draft protocol document. The protocol document was presented to MDOT and FHWA. The team received comments back from stakeholders.</p>			
FISCAL YEAR 2020 PROPOSED ACTIVITIES			
<p>In FY 2020, the research vendor will perform the following key tasks: 1) Complete calibration/validation of the developed model for reporting Measures of Effectiveness (MOE) and Deliverables Templates. 2) Complete the model review & evaluation forms and check lists. 3) Finalize both the primary and secondary reports. 4) Present findings to consultant group as well as a separate presentation for MDOT project managers. This will mark the completion of the project.</p>			
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))			
None.			
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION (Required the last year of the project)			
Expected completion December 31, 2019.			

100% FEDERALLY FUNDED PROJECTS

Sequentially Listed by Job Number

**RESEARCH ADMINISTRATION
TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: AASHTO Engineering Technical Service Programs

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	SPR 1284 (019)	MDOT START DATE	10/1/2018
PROJECT NO.	131576	MDOT COMPLETION DATE (Original)	9/30/2019
OR NO.	OR15-503	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Andre Clover, 517-636-6053 CloverA@michigan.gov		
LEAD AGENCY:	American Association of State Highway and Transportation Officials (AASHTO)		
PROJECT MANAGER	Various - Based on technical focus matter		
CONTRACTOR	Not Applicable		

BUDGET STATUS

FY 2019 Budget			Total Budget		
FY Budgeted Funds	(Original)	\$150,000.00	TOTAL COST	(Original)	\$150,000.00
FY Billed Invoices	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$150,000.00	Total Committed Funds Available		\$0.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.
Not applicable.

PURPOSE AND SCOPE

As a general practice MDOT technical experts each year analyze the benefits to MDOT of services and information shared by TRB's Technical Service Programs. For MDOT FY's 2019 support for TRB's FY 2020 [July 1, 2019- June 30, 2020] AASHTO Technical Service Programs; MDOT experts recommended for approval the list of programs below. The programs provide benefits to the member departments through the pooling of resources and expertise from across the country.

MDOT has the opportunity to support the development and continued operation of each of the following critical programs:

- AASHTO Innovation Initiative (A.I.I.) /Technology Implementation Group (TIG) - \$6,000.
- Development of AASHTO Materials Standards (DAMS) - \$10,000.
- Environmental Technical Assistance Program (ETAP) - \$10,000.
- Transportation Curriculum Coordination Council (TC3) - \$20,000.
- Snow and Ice Cooperative Program (SICOP) - \$4,000.
- Transportation System Preservation (TSP2) - \$20,000.
- Equipment Management Technical Services Program (EMTSP) – \$5,000. (\$2,000 increase in FY 2018.)
- National Transportation Product Evaluation Program (NTPEP) - \$20,000. (\$3,000 increase in FY 2018)
- Highway Safety Policy and Management TSP (SAFETY) - \$10,000.
- Load and Resistance Factor Design (LRFD) Bridges and Structures Specification Maintenance (LRFDSM) - \$15,000.
- Operations TSP (NOCoe) - \$15,000.
- Design Publication Maintenance (DPM) - \$15,000. (Added for MDOT participation in FY 2018)

FISCAL YEAR 2018 ACCOMPLISHMENTS

The Director approved recommendations. MDOT experts shared technology advancements, new improvements, and championed implementation efforts throughout the Department.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The Director approved MDOT expert's program recommendations to support the AASHTO 2020 TSP. MDOT experts shared technology advancements, new improvements, and championed implementation efforts throughout the Department. MDOT remains up to date on state of the practice and science in all TSP's areas.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Each fiscal year, MDOT will review and assess the return on its investment to the list of AASHTO TSP programs noted above. If value is added and the program benefits MDOT, the experts will continue to recommend contributions continue. If value is not being served from a particular program, MDOT may choose to discontinue its contribution.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: AASHTO 3.01 - Construction/Materials Module Enhancement/Implementation and Staff Training

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	N/A	MDOT START DATE	10/1/2016
PROJECT NO.	132251	MDOT COMPLETION DATE (Original)	12/31/2018
	OR16-003	COMPLETION DATE (Revised)	9/30/2020
MDOT TECHNICAL CONTACT	Daniel Burns, 517-290-0000 BurnsD@michigan.gov		
LEAD AGENCY:	AASHTO		
PROJECT MANAGER	AASHTO		
CONTRACTOR	To Be Determined		

BUDGET STATUS

FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$884,200.00	TOTAL BUDGET	(Original)	\$1,262,200.00
	(Revised)	\$513,000.00		(Revised)	
TOTAL FY 2019 EXPENDITURES		\$513,000.00	TOTAL COMMITTED FUNDS AVAILABLE		\$371,200.00

PURPOSE AND SCOPE

The client-server software has become obsolete with the advent of web-based applications. AASHTOWare Project 3.01 Construction Materials is the web-based application that will replace client-server based Field Manager. To fully implement AASHTOWare Project 3.01 MDOT will need to provide assistance, support, enhancement, and training for the application to the MDOT community of users, consultants, contractors, and local agency community of users.

Objectives:

1. Develop a Manual of Practice for the implementation and configuration of a software application for the department.
2. Develop a training method to provide statewide as-needed/just-in-time training to internal and external users.

Tasks:

1. Research state of the art training methods.
2. Analyze, test, and implement system customizations to meet MDOT business processes.
3. Create, implement, and analyze training modules.

FISCAL YEAR 2017 ACCOMPLISHMENTS (Benefits to MDOT)

MDOT project team worked with various internal/external user groups to establish a foundation for identifying and documenting implementation and configuration requirements utilizing User Acceptance Testing [criteria developed by MDOT].

Accomplishments:

1. Developed and completed a Training Plan.
2. Developed customizations and established all global reference data.
3. Developed criteria for the User Acceptance Testing (testing customizations and requested enhancements).
4. Completed first round of system load testing.
5. Upgraded Project 3.01 version to Project 4.0.

Attended the 2017 Annual AASHTO Project Users Group Conference held September 2017. Discussed system logistics, recent software enhancements, and training practices with other AASHTO states.

FISCAL YEAR 2018 ACCOMPLISHMENTS (Benefits to MDOT)

1. Began Developing training materials:
 - o Created standard example training contract to be used for training purposes.
 - o Determined text content for training manual.
 - o Created standard format of manual and determine other related media.
 2. Determined a methodology for training to implement statewide as-needed/just-in-time training to internal and external users.
 3. Training Implementation for pilot projects that included consultants, internal staff, and contractors.
 4. Establish a pilot production environment under a live contract.
 5. Continue load testing in upgraded development environment.
 6. Attended the 2018 Annual AASHTO Project Users Group Conference held September 2018. Discussed system logistics, recent software enhancements, and training practices with other AASHTO states.
- Drafted Request for Proposal (RFP) to hire a consultant to assist with completing training materials and train staff.

FISCAL YEAR 2019 ACCOMPLISHMENTS (Benefits to MDOT)

1. Hired consultant to:
 - o Complete and make necessary refinements to documented training materials and other related media. The consultant continues to make the necessary refinements to the training materials datasets; required in order to hold the training workshop(s).

-
- Implement AASHTO Construction/Materials [Incl. contract] software program training materials statewide. To be completed by the FYE in 2020.
 - 2. Upgrade production environment to version 4.1 for needed enhancements. Pending.
 - 3. Develop a Manual of Practice for the implementation and configuration of a software application for the department.
-

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The expected end date of this project has been extended to ensure accurate data is used in training, which is expected to begin during FY 2020.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion 9/30/2020

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Development of a Transportation System Simulation Manual (TSSM): First Edition

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(176)	MDOT START DATE	6/1/2016
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/30/2017
OR NO.	OR15-540	COMPLETION DATE (Revised)	9/30/2021
MDOT TECHNICAL CONTACT	Jason Firman, 517-636-4547 FirmanJ@michigan.gov		
LEAD AGENCY:	FHWA		
PROJECT MANAGER	Chris Melson @ 202-493-3271 Christopher.Melson@dot.gov		
CONTRACTOR			

BUDGET STATUS

FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$0.00	TOTAL BUDGET	(Original)	\$70,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$0.00	TOTAL COMMITTED FUNDS AVAILABLE		\$0.00

PARTICIPATING STATES

CA (4.1%), CO (5.8%), FL (10.6%), LA (5.8%), MA (4.1%), MD (5.8%), MI (5.8%), MO (2.9%), NV (9.2%), NY (4.1%), OH (17.8%), VA (5.8%), WA (0.5%), WI (12.9%).

PURPOSE AND SCOPE

The goal of this study is to improve the state-of-the-practice in traffic analysis and simulation so public agencies can make the best possible transportation investment decisions based upon high-quality traffic analyses. The Highway Capacity Manual (HCM) and the Highway Capacity Software (HCS) are widely used analytical tools that assess the quality of service for conventional intersections and interchanges. However, they do not assess any of the alternative designs considered in this research study. In part, this study will develop the first edition of a national, definitive guide for transportation analysis, modeling, and simulation – the Transportation System Simulation Manual (TSSM). TSSM will include five major components: (1) Basic Modeling Concepts, (2) Model Building, (3) Verification and Validation, (4) Results Analysis, and (5) Modeling Case Studies and Supplementary Material. More specifically, TSSM will include:

- Definitions (and distinction) of model scoping, building, calibration, and validation.
- Recommended practices and needs for model scoping, building, calibration, and validation.
- Calibration and validation objectives and target values.
- Performance measurement reporting and visualization.

FISCAL YEAR 2016 ACCOMPLISHMENTS (Benefits to MDOT)

The active research project underway; titled "HCM Guidelines for Alternative Intersections", is nearing completion. Final chapters 23 & 34 (chapters on ramp terminals and alternative intersections) have been reviewed and accepted by the HCQS subcommittee for inclusion in the 6th Edition of the Highway Capacity Manual.

During this period the TAC met to discuss, reviewed, and approved a new research effort to fund. This new effort will develop a Transportation System Simulations Manual (TSSM). TRB formed a Task Force on simulation (AHB80T) in July 2015 to oversee the development of a TSSM. The development of the TSSM will build upon the framework outline that has been approved by this Task Force -- and will include five major components: (1) Concepts, (2) Model Building, (3) Verification and Validation, (4) Results Analysis, and (5) Case Studies and Supplementary Material. The TSSM project is anticipated to be awarded late September or early October 2016.

A research consultant was selected, and a consultant/contract kickoff meeting was scheduled for October 3, 2016.

FISCAL YEAR 2017 ACCOMPLISHMENTS

During this first quarter of the project, the FHWA project team completed an initial set of on-time deliverables including stakeholder meeting minutes, a comprehensive stakeholder list, a revised project work plan, and a state-of-the-practice outline. The team solicited and received a set of "top five TSSM priorities" from several members of the Pooled Fund Study. The team met with TRB representatives to formulate a tentative plan towards TSSM publication and distribution. The team coordinated with TRB Task Force members and friends towards obtaining their technical input, and towards renewing their motivation to maintain the TSSM after its initial period of development. The team received helpful feedback during the first stakeholder webinar, and during the TRB conference.

The FHWA project team completed a second set of deliverables including stakeholder meeting minutes, a state-of-the-practice report, and a TSSM annotated outline. The team identified a content management system and activated an online comment tracking system. The team received helpful feedback during the second and third stakeholder webinars. The team and its stakeholders reached agreement on an overall TSSM chapter sequence, and on a set of critical need chapters (i.e., chapters 5 through 9).

The project team began developing the critical need chapters (chapters 5 through 9) and obtained stakeholder feedback on these chapters. Stakeholders will continue to be provided opportunities for feedback and are invited to project team meetings on a bi-monthly basis (the most recent being July 10th).

Developed state-of-the-practice report.

FISCAL YEAR 2018 ACCOMPLISHMENTS

The Glossary of Connected and Automated Vehicle technology terms was completed and published. Selected candidate projects for the calendar year were "V2I Queue Warning" and "Using Third Parties to Deliver V2I." Pooled fund study transition planning was completed resulting in a change of study number to be effective for FY 2019.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The project was awarded to Leidos and discussions began on the project work plan.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Due to the growing use, need, and acceptance of traffic analysis and simulation tools; this coming FY the project aims to develop a Transportation System Simulation Manual (TSSM) - delivering to users the concepts, guidelines, and procedures of simulation modeling. The development and advancement of the TSSM will help advance analysis for professionals lacking a centralized, unbiased, authoritative source of theory, best practices, and lessons learned. The ultimate goal of TSSM is to address at a minimum the following: Differing scales of modeling, integration of models, model inputs and data formats, data summary and analysis, data storage and model use, calibration/validation of simulation, alternative analysis, post processing of model data, and interpretation.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

The pooled fund website is not up to date. It appears several investigations are planned/scheduled for completion in FY 2020 and FY 2021. MDOT has revised its active participation through FY 2021.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

The project is still ongoing. A manual will be developed in which MDOT will be able to use to help produce consistent and defensible analysis from work created by MDOT and/or consultants. MDOT has fulfilled its total pledge commitment of \$70,000 as of September 30, 2017. MDOT will remain an active partner state until all deliverables and a final report is completed/submitted to FHWA.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Research Program to Support the Research, Development, and Deployment of System Operations Applications of Vehicle Infrastructure Integration (VII)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(206)	MDOT START DATE	10/1/2012
PROJECT NO.		MDOT COMPLETION DATE (Original)	6/30/2020
OR NO.	OR09-146	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Collin Castle, 517-636-0715 CastleC@michigan.gov		
LEAD AGENCY:	Virginia Department of Transportation		
PROJECT MANAGER	Michael Fontaine, 434-293-1982 Michael.Fontaine@VDOT.Virginia.gov		
CONTRACTOR			

BUDGET STATUS

FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$50,000.00	TOTAL BUDGET	(Original)	\$450,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$50,000.00	Total Committed Funds Available		\$0.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

AZ, CA, FL, MI, MN, NJ, NY, PA ,TX ,UT, VA, WA, WI

PURPOSE AND SCOPE

Through a set of pooled fund studies, the Virginia Department of Transportation (VDOT) is working with federal, state and local departments of transportation, to establish a multi-phase program to facilitate the field demonstration, and deployment of Connected Transportation Systems infrastructure applications. In Phase I, the participants are focused on modeling, development, engineering and planning activities that will aid transportation agencies in justifying and promoting the largescale deployment of Connected Transportation Systems. Phase 2, of the program will continue research and development to prepare agencies to deploy connected vehicle environments.

Scope of Work:

The pooled fund study will focus on the following:

- Development and evaluation of Connected Transportation Systems large-scale system level operations applications
- Independently research and address issues that will affect the deployment of Connected Vehicle systems by state and local transportation agencies
- Support AASHTO's Strategic and Deployment Plans
- Support USDOT's Connected Vehicles Programs and initiatives

FISCAL YEAR 2016 ACCOMPLISHMENTS

1. Completed development of the second phase of the Multi-Modal Intelligent Traffic Signal System program.
2. Began an initiative to coordinate with the Society of Automotive Engineers for the development of DSRC messaging standards.
3. Begin development of a project to create a standard "Basic Infrastructure Message" to be used on uniform DSRC roadside unit installations.
4. Completion of the Phase 2 deployment of the Multi-modal Intelligent Traffic Signal System.
5. Began deployment of second Phase of "Using DSRC for Road Weather Management" project, which includes a deployment in Michigan.

FISCAL YEAR 2017 ACCOMPLISHMENTS

1. Began development of the third phase of the Multi-Modal Intelligent Traffic Signal System program.
2. Coordinated with the Society of Automotive Engineers for the development of DSRC messaging standards, including support of the J2735 Message sets and J2945 performance standards.
3. Continued development of the standard "Basic Infrastructure Message" which contains infrastructure-based content for multiple uses on DSRC roadside unit installations.
4. Completed deployment of second Phase of "Using DSRC for Road Weather Management" project, which includes a deployment in Michigan on two intersections on Saginaw Hwy in Lansing, MI, as well as two MDOT fleet vehicles.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Pooled Fund Study Overall:

- TAC teleconference calls were held on July 26, August 30, and September 27 in 2019.
- Commitments are being received for the current/new PFS (TPF-5(389)) for FY2019 and beyond.
- Finalized future project selections.

Multi-Modal Intelligent Traffic Signal System (MMITSS) Phase 3 - Deployment Readiness Enhancements

- Teleconference calls were held on July 18, August 15, and September 19.
- MMITSS Development Group Meetings began and were held on August 22 and September 26.

Connected Traffic Control Systems (CTCS)

- Teleconference calls were held on July 16, August 20, and September 17.
- A Stakeholder Needs Workshop was held on April 30 in conjunction with the PFS meeting in Michigan.
- Task 4: Assessment of TRL - completed.
- Task 5: Development of CTCS Research Plan - Final report under review.
- Task 6: Concept of Operations - Workshop to be held in October.

V2I Queue Advisory/Warning

- Task 1: Project Management Plan (completed) and Systems Engineering Management Plan (completed)
- Task 2: Assessment of Prior Work & Stakeholder Input - A draft report is under review.
-

Using Third Parties to Deliver I2V

- Task 2: Survey of the Current Status - Concept of Operations Workshop was held on September 11 in Minnesota.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Pooled Fund Study Overall

- a. Monthly calls will be held in each month.
 - b. A face-to-face meeting will be held in Tampa, FL on December 10 - December 12.
 - c. The future project topics approved by the members will be initiated.
2. Multi-Modal Intelligent Traffic Signal System (MMITSS) Phase 3 - Deployment Readiness Enhancements
 - a. Monthly project calls will be held in each month.
 - b. Development Group Meetings will continue to be held
 - c. Task 4 field tests and demonstrations will be initiated.
 3. Connected Traffic Control Systems (CTCS)
 - a. Monthly project calls will be held in each month.
 - b. Task 5 Development of CTCS Research Plan report will be completed.
 4. V2I Queue Advisory/Warning
 - a. Monthly project calls will be held in each month.
 - b. Task 2 Assessment of Prior Work & Stakeholder Input will be completed.
 5. Using Third Parties to Deliver I2V
 - a. Monthly project calls will be held in each month.
 - b. Work will continue as planned.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

MDOT began its funding pledge contribution in FY's 2009 and 2010 to the old study TPF-5(159). It continued its state partner status in FY's 2013-2017 under the new study TPF-5(206). The study revised completion date is June 30, 2020. This was confirmed on 11/06/2017 via phone call to Mr. Michael Fontaine [Lead Agency Contact].

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MDOT will benefit from the information developed under all projects. In particular, the "Using DSRC for Road Weather Management" Phase 2 project includes a deployment of equipment and evaluation of operations in Lansing, MI. MDOT is evaluating the Multi-modal Intelligent Traffic Signal System application for use in Michigan.

MDOT has a strong interest in leveraging the work from multiple development projects to be implemented in Michigan's Connected Vehicle environment.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Highway Safety Manual Implementation

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(255)	MDOT START DATE	11/9/2015
PROJECT NO.	Not Applicable	MDOT COMPLETION DATE (Original)	12/31/2019
OR NO.	OR15-527	COMPLETION DATE (Revised)	12/31/2020
MDOT TECHNICAL CONTACT	Stephen Shaughnessy, 517-373-8950 ShaughnessyS@michigan.gov		
LEAD AGENCY:	FHWA		
PROJECT MANAGER	Jerry Roche, 515-233-7323 Jerry.Roche@fhwa.dot.gov		
CONTRACTOR			

BUDGET STATUS					
FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$20,000.00	TOTAL BUDGET	(Original)	\$80,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$20,000.00	TOTAL COMMITTED FUNDS AVAILABLE		\$0.00

PARTICIPATING STATES	
ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.	
LTRC, CA, ID, IL, KS, KY, LA, MI, MO, MS, NC, NJ, OH, OK, OR, PA, TX [2019], UT, WA, WI, and WV.	

PURPOSE AND SCOPE

The objectives of the study are (1) to advance ongoing efforts by lead states to implement the Highway Safety Manual (HSM), and (2) to expand implementation to all states. This study would be coordinated with other ongoing and planned implementation activities sponsored by AASHTO, FHWA, and TRB, including NCHRP Project 17-50 "Lead States Initiative for Implementing the Highway Safety Manual" It will also be coordinated with projects that develop content for future editions of the HSM including NCHRP Project 17-45 "Enhanced Safety Prediction Methodology and Analysis Tool for Freeways and Interchanges" NCHRP Project 17-54 "Consideration of Roadside Features in the Highway Safety Manual" and Transportation Pooled-Fund Study TPF-5(099) "Evaluation of Low Cost Safety Improvements."

This study would conduct research tasks and develop products that would enable States to accelerate their implementation of the HSM. The specific tasks and products would be identified and prioritized by a Technical Working Group consisting of one representative each from participating agencies. Specific tasks may include: (1) developing a calibration manual to accompany the HSM that provides practical advice and examples on how best to adapt HSM calibration procedures to meet the needs of a particular agency, (2) developing technical guidance for agencies on developing safety performance functions, and (3) developing guidance for agencies on assembling and managing the data needed for safety analyses.

The study would also facilitate Technical Working Group representative's participation in peer exchanges and other forums through which agencies can exchange information, best practices, lessons learned, and remaining challenges in implementing the HSM appropriately into agencies' system planning, project planning and preliminary engineering, design and construction, and operations and maintenance procedures and processes. These exchanges would feed an annual process through which the Technical Working Group identifies and prioritizes future tasks to be conducted under the study.

FISCAL YEAR 2016 ACCOMPLISHMENTS

- A finalized list of State-adapted HSM Part C spreadsheets based upon input from State representatives was developed for posting at the Crash Modification Factor (CMF) Clearinghouse.
- A finalized a list of State developed or calibrated Safety Performance Functions (SPFs) based upon feedback from State representatives was developed for posting at the CMF Clearinghouse.
- A preliminary analysis comparing State developed SPFs and State calibration factors was conducted for HSM SPFs as a first step in an evaluation of the feasibility of a "quick and dirty" method that States could use to determine whether an existing SPF may be suitable for use in the State without calibration.
- The "Model State Policies and Procedures for Use of HSM" contractor delivered the draft final report on June 13, 2016. State representatives and FHWA staff provided review comments on July 5, 2016.
- The "Scale and Scope of HSM Implementation in the Project Development Project" contractor delivered the 3rd draft of the final report on June 19, 2016. State representatives and FHWA staff review comments are due July 15.
- Held a virtual quarterly business meeting on May 16, 2016.

Please list those deliverables that will benefit MDOT if implemented. The payoff from participating in this pooled-fund study is minimizing duplication of efforts by all the states and maximizing our resources based on national priorities of delivering products that support the implementation of the HSM.

FISCAL YEAR 2017 ACCOMPLISHMENTS

- Virtual meetings were held on May 22 and June 27, 2017
- At the June 27th meeting participants provided feedback on the Life Cycle Benefit–Cost Analysis guide and an overview of an existing spreadsheet tool. The group is going through modifications of the tool to perform economic analysis of safety projects.
- A draft of the Safety Performance for Intersection Control Evaluation (SPICE) tool was developed and presented for feedback to state representatives.

Modifications are being made to the Network Screening Best Practices contract for the NCHRP 17-50 project in order to enable the contractor to perform work for this study.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Meetings held on January 26th, and April 5th. As part of the Highway Safety Benefit Cost analysis tool, the Crash Cost Values report was finalized and is posted at <https://safety.fhwa.dot.gov/hsip/docs/fhwasa17071.pdf>. A Safety Benefit Cost Analysis Guide was completed. A Safety Benefit Cost Analysis (BCA) Tool was finalized. The reports and tool are available online.

SPICE version 2.0 was completed and is currently undergoing testing. Safety Analysis Needs Assessment for Performance Based Practical Design (PBPD) and Transportation Systems Management and Operations (TSMO) project draft report was disseminated via webinar in April. Comments were received in May.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The lead agency conducted a project progress meeting with Technical Advisory Committee (TAC) members on May 29, 2019. The peer exchange summary report was completed and posted to pooled fund website. Safety Analysis Needs Assessment for PBPD and TSMO 3rd draft was completed and disseminated in May 2019. Ideas solicited and discussed for future projects.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

TPF website has not been updated sufficiently to know FY 2020 plans.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

The pooled fund study has a revised completion date of December 31, 2020. Research Administration plans to initiate briefing meetings with the MDOT Technical Contact (TC) and the appropriate Research Advisory Committee (RAC) chair and Focus Area Manager (FAM) to discuss review of project products/deliverables and whether an implementation action can be developed at MDOT. If so, the MDOT TC will need to develop a draft Implementation Action Plan for the RAC to recommend review/approval by the MDOT Research Executive Committee prior to implementation at MDOT.

Possible implementation activities may include:

- Developing and/or confirming an approved list of Crash Modification Factors for MDOT use.
- Updating the HSM spreadsheet based on results of current SPF research.
- Utilizing methodology for updating the SPFs.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Accelerated Performance Testing for the NCAT Pavement Test Track					
FUNDING SOURCE: <input checked="" type="checkbox"/> FHWA <input type="checkbox"/> OTHER (PLEASE EXPLAIN)					
TPF NO.	TPF-5(267)	MDOT START DATE		4/15/2015	
PROJECT NO.		MDOT COMPLETION DATE (Original)		03/31/2020	
OR NO.	OR15-520	COMPLETION DATE (Revised)			
MDOT TECHNICAL CONTACT	Curtis Bleech, 517-322-5769 BleechC@michigan.gov				
LEAD AGENCY:	Alabama DOT				
PROJECT MANAGER	Michelle Owens, 334-353-6942 OwensM@dot.state.al.us				
CONTRACTOR					

BUDGET STATUS					
FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$330,000.00	TOTAL BUDGET	(Original)	\$990,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$0.00	TOTAL COMMITTED FUNDS AVAILABLE		\$0.00

PARTICIPATING STATES	
ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.	
AL, CO, FL, GA, IL, KY, MN, MO, NY, NC, OK, SC, TN, VA, and WI	

PURPOSE AND SCOPE
<p>This is a partnership to address National needs for research in Pavement Preservation and Asphalt Mixture Performance Testing. The National Center for Asphalt Technology (NCAT) is partnering with MnROAD for the first time in the 2015 research cycle to execute pavement preservation and asphalt mixture performance testing experiments with a nationwide implementation impact. Research sponsors will have decision making authority on the targeted use of the funding they provide, meaning that states can choose which facility (either NCAT or MnROAD) will be the focus of their research investment. It is expected that many treatments/pavements will be studied at both locations. Background information on the scope of the NCAT/MnROAD partnership is provided as an attachment. Positive experiences with implementable findings that reduce the life cycle costs of pavements and facilitate rapid deployment of sustainable technologies have made past research at both NCAT and MnROAD an outstanding investment for numerous state DOTs. The yield will broaden the scope of implementable findings, while at the same time expand the capabilities of both facilities on complementary research through close collaboration.</p> <p>The scope of work for the pooled fund project will include:</p> <ol style="list-style-type: none"> 1. Hauling materials to the project from offsite locations. Material donations are typically secured by state sponsors, while reasonable hauling expenses are handled by the pooled fund. 2. Rebuilding sections in accordance with sponsors' directives via competitively bid subcontracts administered by NCAT. It is anticipated that equipment rental, aggregate hauling, liquid asphalt supply and delivery, plant production, and mix placement may all be procured via competitively bid subcontracts. Additional preservation treatment sections will be applied to a nearby highway as well as at the MnROAD test facility. 3. Installing both environmental (i.e.: multi-depth pavement temperature probes) and response instrumentation (e.g.: high speed stress and strain gages) in new experimental sections. 4. Operating a 5-truck heavy triple-trailer fleet on the NCAT test oval in order to apply accelerated truck traffic following the completion of construction. Actual human drivers operate the vehicles in order to provide realistic vehicle wander. 5. Measuring field performance each week when the fleet is parked to fully document the changes in surface condition as a function of traffic and temperature. High-speed pavement response will also be measured on a weekly basis in structural sections. Surface friction will be measured on a monthly basis. Performance will be measured on off-Track pavement preservation sections on at least a monthly basis. 6. Conducting laboratory testing to quantify basic material and mix performance properties, which will serve as the basis of performance model development. 7. Comparing predicted and measured pavement response, as well as predicted and measured cumulative pavement damage, in order to validate then calibrate prevailing M-E methodologies and to quantify the life extending benefit of various pavement preservation alternatives.

FISCAL YEAR 2015 ACCOMPLISHMENTS

Conference call meetings to discuss and select the roads in Minnesota to perform the treatments on and selecting the various treatments to be applied. MDOT had direct input on the sections selected.

FISCAL YEAR 2016 ACCOMPLISHMENTS

Establishment of teams in the areas of Tech Transfer, Flexible Pavements, Rigid Pavements, Geotechnical and Preventive Maintenance to identify future research needs and development of long-term construction plans to support research for the specific research needs. Provided technical transfer training on intelligent compaction to various entities. Construction of "Cracking Group Study" cells and "Preservation Group Study" cells.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Continued monitoring of various test cells and continued material testing and material testing and analysis of the preliminary data collected to date.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Each quarter approximately 2.5 Million ESAL's are applied to the surface of the NCAT Pavement Test Track when the truck fleet is operational.

During FY 2018 the research team continued monitoring, data collection, and reporting of the various test cells. Comparison of the predicted performance and pavement response to the actual pavement performance, based on in-situ testing and actual engineering properties using Mechanistic Empirical Modeling.

Reported findings from the Cracking Group Experiment.

Complete construction of additional test cells.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Continue weekly, monthly, and quarterly pavement surface condition data collection. Update the Web Performance Reports to reflect the most recent data collected and vetted. A 6-month sponsor meeting is hosted each spring and fall. Spring meetings are held at NCAT (typically in May or June) and fall meetings are held at MnROAD (typically in September or October). At both locations, meetings consist of technical presentations and test section inspections.

- Continued to monitor and perform data collection on the Preservation Group.
- Report findings from the Preservation Group.
- Construct and monitor new test cells.
- Continue to identify research needs of participating members.
- As of June 30, 2019, 98% of the work has been completed and 99% of the budget has been expended.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

MDOT has met its full SPR-II fund commitment in the amount of \$990,000 as of September 30, 2017. MDOT will continue to be an active partner in this project until all deliverables and reports are completed and approved by Technical Advisory Committee (TAC) members.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

The findings of the research have not been presented in total at this time; however, project personnel travel to the sponsor states on demand to promote deployment through meetings, presentations, and field projects.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Development of an Improved Design Procedure for Unbonded Concrete Overlays

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(269)	MDOT START DATE	4/13/2012
PROJECT NO.		MDOT COMPLETION DATE (Original)	4/30/2019
OR NO.	OR14-036	COMPLETION DATE (Revised)	11/30/2019
MDOT TECHNICAL CONTACT	Benjamin Krom, 517-322-6855 KromB@michigan.gov		
LEAD AGENCY:	Minnesota Department of Transportation		
PROJECT MANAGER	Debra Fick, 651-366-3759 deb.fick@dot.state.mn.us		
CONTRACTOR	University of Minnesota		

BUDGET STATUS

FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$0.00	TOTAL BUDGET	(Original)	\$60,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$0.00	TOTAL COMMITTED FUNDS AVAILABLE		\$0.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

GA, IA, KS, MI, MN, MO, NC, and OK

PURPOSE AND SCOPE

It is the goal of this project to develop a stand-alone national design procedure that will result in improved performance and life-span prediction of unbonded concrete overlays constructed over existing concrete or composite pavements. The procedure should be based on mechanistic-empirical principals and developed in a way such that it could be easily adopted into future versions of the MEPDG or DARWin-ME design procedures. The new procedure must incorporate the best features from existing UCOC designs, as well as develop improved structural and fatigue models that consider the effects from the environment and the behavior of the wide range of interlayer systems currently in use.

FISCAL YEAR 2012 ACCOMPLISHMENTS

The participating states met via conference call and web conference on June 28, 2012, to discuss the contents of the Request for Proposals (RFP). Based on that input, the Lead Agency developed the final RFP and posted it on September 4, 2012, with proposals due by October 2, 2012.

FISCAL YEAR 2013 ACCOMPLISHMENTS

The contract with the University of Minnesota was executed on June 17, 2013 and began with a literature review and the creation of a database of existing unbonded concrete overlay projects.

FISCAL YEAR 2014 ACCOMPLISHMENTS

Two Technical Advisory Panel meetings occurred via web-conference this Fiscal Year (FY), on December 16, 2013, and May 27, 2014, with the purpose of keeping all member states informed on project progress. Task 1 was completed this FY, which included a literature review of existing unbonded concrete overlay design procedures. A survey to states was also sent out and MDOT provided a lot of detailed information on our existing unbonded overlay projects as part of this survey. The research team also met with Minnesota DOT pavement experts to gather information about the historical performance of unbonded concrete overlays in Minnesota. Extensive pavement management system records and personal knowledge/experience with unbonded overlays were transferred to the research team. The University of Minnesota's subcontract with the University of Pittsburgh was not executed until May of 2014, so the Task 2 work is behind schedule. For the laboratory testing in Task 2, the University of Pittsburgh requested that member states provide material samples for testing (concrete specimens with open-graded & dense-graded interlayer asphalt attached). MDOT has acquired concrete samples with both asphalt interlayer types and is in the process of delivering them to the University of Pittsburgh. MDOT staff has also hosted some members of the research team (University of Pittsburgh), touring the Michigan unbonded concrete overlay projects that were of interest to them.

Website Updates:

- Work continued on development of a longitudinal cracking model, which will be used in the UBOL design procedure being developed.
- Task 2 was the major focus during July-September 2014. Technical Advisory Committee (TAC) members began securing/sending material samples for testing characterization of the interlayer.

- Selection of projects for supplementary non-destructive testing is underway. Some of the selected sites were visited by the research team in 2014.

FISCAL YEAR 2015 ACCOMPLISHMENTS

TAC meeting occurred via web-conference this FY (June 24, 2015) to keep all member states informed on the status of the project. A lot of progress has been made on Task 2 by the University of Pittsburgh. Work consisted of laboratory testing of beam samples to characterize the behavior of various interlayer materials in relation to reflective cracking. This work was documented in a draft report submitted for review by the TAP. All Task 2 work (lab testing) is scheduled to be complete by September 30, 2015.

FISCAL YEAR 2016 ACCOMPLISHMENTS

TAC meeting occurred via web-conference this FY (February 22, 2016) to keep all member states informed on the status of the project, to present on the completed Task 2 (lab testing) report and the draft Task 3 (structural model development) report and findings. The research team requested that member states provide any faulting data on in-service concrete overlays. MDOT collected and supplied nearly 200 raw longitudinal profiles, collected from 1994-2015, on a sampling of in-service concrete overlays to assist the research team in the calibration/validation of their proposed faulting model. The Task 3 report was finalized in March. Task 9 (lab testing added per contract amendment #2) on the specimens cut from SR50, in Bridgeville, PA, was also completed. Using all lab testing results and other models, the research team investigated the structural behavior (deflection, cracking and faulting) of unbonded concrete overlays. The understanding of this structural behavior, as implemented in the developed mechanistic models, will form the backbone of the unbonded concrete overlay design procedure.

FISCAL YEAR 2017 ACCOMPLISHMENTS

TAC meeting occurred via web-conference this FY (December 20, 2016) to keep all member states informed on the status of the project, and to present on the final Task 3 (structural model development) report and findings. The final Task 9 (lab testing added per Contract Amendment #2) report was submitted in January 2017. The research team continued work on the cracking and faulting models and has assembled the faulting model and conducted its initial calibration for conventional overlay slabs (with a width greater or equal to 12ft) pavements, but still needs to be calibrated for short slabs (6ft by 6ft). The research team also began assembling a database of temperature data simulations using the Integrated Climate Model (ICM) to develop equivalent temperature distributions for use with the performance models. The Principal investigator, Lev Khazanovich, announced that he was leaving the University of Minnesota on December 31, 2016, and will be moving to the University of Pittsburgh. An initial plan to keep the University of Minnesota as the prime contractor did not work out, so the decision was made to close the contract with the University of Minnesota and move the contract to the University of Pittsburgh. Therefore, the original contract with the University of Minnesota was allowed to expire on May 31, 2017, and a new contract with the University of Pittsburgh was developed and submitted for approval. As part of the closing out of the University of Minnesota contract, the research team prepared and submitted a report for the work completed to date in Task 4 (UBOL procedure development). Since June 1, 2017, the project has been on hold until the new contract with the University of Pittsburgh is approved.

FISCAL YEAR 2018 ACCOMPLISHMENTS

A new contract with the University of Pittsburgh was approved on November 8, 2017. On March 14, 2018, the research team provided the Technical Advisory Panel with the "alpha-build" of the design procedure software to install and evaluate. One Technical Advisory Panel meeting occurred via web-conference this FY (March 19, 2018) to keep all member states informed on the status of the project, to present on the performance models included in the design procedure (transverse cracking, transverse joint damage and transverse joint faulting), and a demonstration of the "alpha-build" of the design procedure software. The research team received valuable feedback from the Panel on the software. Additionally, the research team developed a JPCP cracking model for short (6ft x 6ft) slabs, modified the built-in curing model and the equivalent temperature calculation for the design procedure. Work to incorporate these changes, as well as the new faulting model, into the design procedure software continued. A revised version of the design procedure software was tested by MnDOT staff to demonstrate that successful progress was being made. The trials were successful, but unfortunately the research team still needs more time to fully incorporate the new faulting model into the procedure. Finally, the proposed guidelines on the suitability of unbonded concrete overlays was re-evaluated.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The research team completed draft reports for Tasks 1-4, listed below, summarizing the development of the cracking and faulting models, creating a user guide for the design software, and refining the guidelines for selection of a suitable interlayer for an unbonded concrete overlay. The draft final report and design software are under review by the Technical Advisory Panel.

Task 1: Develop UCOCF Procedure: Final version of design procedure.

Task 2: Create User Guide for Procedure.

Task 3: Evaluate Guidelines on Suitability of UCOCF.

Task 4: Draft Final Report.

Task 5: Final Report is underway.

The final TAC meeting was held via web-conference on September 24, 2019.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

On April 22, 2015, the contract was amended to accommodate additional testing and add time needed to complete the project. The entire project is now scheduled for a May 31, 2017 completion date.

Contract amendment #2 was approved on September 14, 2016 to perform additional laboratory testing (adding Task 9 to the project) and extend the due dates for Tasks 4 and 5. The additional testing will exceed the project budget by \$8,324.88. Therefore, FHWA has agreed to fund this shortfall, allowing this additional work to be completed. The research team will make every effort to accomplish this additional work, as well as the remaining tasks, within the currently scheduled May 31, 2017 completion date.

The original contract with the University of Minnesota was allowed to expire on May 31, 2017, and a new contract with the University of Pittsburgh was developed, submitted and is awaiting approval. Currently, the new contract lists the following dates:

- Final version of design procedure to be delivered by January 1, 2018.
- Draft final report to be delivered by May 31, 2018.
- Final report to be published before July 31, 2018.
- End of the contract: September 30, 2018.

A new contract with the University of Pittsburgh was approved on November 8, 2017, and was then amended in September 2018, allowing a six-month time-only extension.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2020.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(281)	MDOT START DATE	10/1/2017
PROJECT NO.		MDOT COMPLETION DATE (Original)	6/30/2021
OR NO.	OR18-012	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Rebecca Curtis, 517-449-5243 CurtisR4@michigan.gov		
LEAD AGENCY:	FHWA		
PROJECT MANAGER	Justin Ocel, 202-493-3080 justin.ocel@dot.gov		
CONTRACTOR			

BUDGET STATUS

FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$30,000.00	TOTAL BUDGET	(Original)	\$125,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$30,000.00	TOTAL COMMITTED FUNDS AVAILABLE		\$45,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

Manitoba Transportation, FHWA, IA, IL, IN, KS, MI, MN, SD, WI

PURPOSE AND SCOPE

The objective is to develop the Steel Bridge Research, Inspection, Training, and Education Engineering Center (S-BRITE Engineering Center) focused on existing steel highway bridges. This National Center will be the first of its kind and will become the leading education, training, research, and engineering center related to all aspects affecting the existing aging steel bridge and structure inventory. Although the Center will be focused on highway bridges, it will also support stakeholders of steel railroad bridges as well as steel ancillary structures, such as lighting towers and sign supports. The Center will contribute to improved asset management decisions for DOTs, FHWA, and other partners relative to existing steel bridge inventory. This impact will be realized by ensuring existence of the following:

- High quality inspection data
- Advanced predictive models
- Improved management decisions
- Timely and effective execution

This will be accomplished by providing solutions to the following:

- inspection reliability issues
- inadequate technical expertise
- training and education opportunities for students and professionals
- short-term and long-term research needs

Once the center is successfully operational, other materials and systems, such as concrete, prestressed, and post-tensioned structures may be added.

Educational Aspects

A long-term goal of the S-BRITE Center is to create the next generation of bridge engineers and inspectors who are properly educated to be effective stewards of the existing aging steel bridge inventory. At the university level, the development of a new "minor" or certificate within Civil Engineering is proposed that will prepare engineering students for a career in the area of transportation structures. At the professional level, high-quality, specialized short courses for professionals will be developed and targeted at those individuals currently responsible for the existing infrastructure. The courses would go beyond the current NHI course level.

The Center would collaborate with external technical schools, in order to develop a new area of educational expertise, specifically, the Steel Bridge Infrastructure Specialist. Both one and two-year degree programs are envisioned and would involve the development of several new courses within existing degree programs.

A major goal is to develop training and performance testing criteria to establish rational criteria for defining a "team leader" and developing reliable inspection protocols. Further, performance testing methodologies and criteria will be developed and implemented to improve the reliability of inspections by those who are certified through the Center.

Bridge Component Gallery

Although training, education, and research are the overall focus of the Center, the cornerstone of the S-BRITE Engineering Center will be a multi-acre gallery which will include full-scale bridge structures, portions of complete structures, and individual components that will include a host of common and uncommon details used in steel bridges. Similar centers exist for the aircraft, ship, and offshore industries, though nothing has been developed for the steel bridge industry.

The gallery will provide a unique hands-on experience for education of individuals of all levels regarding steel fabrication, deterioration, inspection techniques, etc.

Since the bridge components will not actually be in service and will be in more accessible conditions, costly traffic control and extensive fall-protection will not be required during training. However, they will be situated so that real-world conditions exist to truly simulate in-situ inspection conditions. Having such a "living laboratory" will also be incredibly useful for research tools being developed for inspection, durability modeling, and performance testing of inspectors.

Distributed Expertise Network (DEN)

To help fill the technical voids found at most DOTs, a unique team of experts will be assembled through the S-BRITE Center to create a Distributed Expertise Network (the DEN). Some of these individuals will be housed locally at the Center while others will be located at their respective institution. The DEN will serve the role that no longer exists in many individual state DOTs today, specifically the existence of a group of highly specialized technical experts that are "on-call" to assist as issues arise. These experts will effectively be "on call" to the Center and the participants and will be able to travel to the participant's location if required and per the funding level provided. There would be no need for special subcontracts between the individual state and the expert since the contracts will already be in place as participants of the Center.

FISCAL YEAR 2018 ACCOMPLISHMENTS

In 2018, MDOT received assistance in evaluating the Cut and Cooley River bridges. We also received guidance in pack rust removal techniques on riveted members and fatigue analysis of link plates.

FISCAL YEAR 2019 ACCOMPLISHMENTS

In 2019 MDOT sent one staff member to training at the S-BRITE Center as well as hosted the S-BRITE training course "Inspecting Steel Bridges for Fatigue". S-BRITE performed field reviews on two MDOT structures (Grand Haven Bascule Bridge and M-14 & US-23 BR over MDOT RR & Huron River) and several plan reviews. We received guidance on CIF details and assistance in evaluating cracking in primary fracture critical girders. Plan reviews included the following structures:

- B02-70014: US-31 over Grand River (Grand Haven Bascule Bridge)
- R01-81075: M-14 & US-23 BR over MDOT RR & Huron River
- B01-23151: I-96 EB over Grand River & Billwood Highway
- B02-23151: I-96 WB over Grand River & Billwood Highway
- B01-31012: US-41 & M-26 over Portage Lake (Houghton Hancock Lift Bridge)
- S05-63103: I-696 over I-75 & 4 Ramps

Budgeted Amounts:

\$30,000 in each FY 2019 and FY 2020, and \$15,000 in FY 2021.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

In 2020 MDOT intends to send 2 staff members to training at the S-BRITE Center. In addition, we plan to continue to utilize S-BRITE for as-needed field and bridge plan reviews based on fracture critical inspection findings.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project completion expected FY 2021.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Aurora Program

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(290)	MDOT START DATE	8/1/2014
PROJECT NO.		MDOT COMPLETION DATE (Original)	5/31/2019
OR NO.	OR14-057	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	James Roath, 517-230-5361 RoathJ1@michigan.gov		
LEAD AGENCY:	Iowa Department of Transportation		
PROJECT MANAGER	Khyle Clute, 515-239-1646 Khyle.Clute@iowadot.us		
CONTRACTOR			

BUDGET STATUS

FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$25,000.00	TOTAL BUDGET	(Original)	\$150,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$25,000.00	TOTAL COMMITTED FUNDS AVAILABLE		\$0.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

AK, AZ, CA, CO, DE, IA, IL, KS, MI, MN, NY, ND, OH, PA, UT VA, WI, and Ontario Ministry of Transportation

PURPOSE AND SCOPE

The purpose of this project is to:

1. Improve dissemination of road weather information to transportation providers and end users, ultimately increasing safety by reducing potential weather-related incidents and improving transportation safety, reliability, and mobility in both urban and rural areas.
2. Improve the efficiency of maintenance operations.
3. Aid in the development of technologies that seamlessly integrate to facilitate the formation of partnerships between maintenance and operations and facilitate the dissemination of road weather information.
4. Develop initiatives that assist public agencies in deploying Road Weather Information System (RWIS) technologies and methodologies.
5. Encourage greater cooperation and information exchange between transportation agencies and the other agencies and groups.
6. Support development of expanded uses of RWIS technologies.

The program's mission is to support cooperative research, evaluation, and deployment of innovative technologies that advance road weather monitoring and forecasting in highway design, construction, maintenance and operations and to serve as an international advocate for expanded uses of these technologies.

FISCAL YEAR 2014 ACCOMPLISHMENTS

Completion of project 2009-01: Summary and Comparison of Agency Experience with Sensors.

This project was funded to compile a summary of various environmental sensors and the experience agencies have had with each sensor. This information will be utilized by MDOT when selecting sensor types and models.

Completion of project 2007-05: Multiple Use ITS Data Collection Practices.

This project was funded to summarize the previous experience of other states when combining Intelligent Transportation Systems (ITS), traffic devices, etc., at one location. MDOT participated in this survey and continues to strive to combine as many of these devices at one location as possible.

Completion of project 2013-01: National Winter Maintenance Peer Exchange.

This project was completed and finalized a gathering to allow agencies to network and share ideas and innovations. MDOT is an active participant in this meeting.

FISCAL YEAR 2015 ACCOMPLISHMENTS

Completion of project 2015-02 2015: National Winter Maintenance Peer Exchange.

This conference had excellent attendance. State best practices were again well received.

Completion of project 2012-03: Cameras and Operational Impact of Remote Road Condition Monitoring

This study in Utah evaluates the benefit of cameras in winter weather remote monitoring.

FISCAL YEAR 2016 ACCOMPLISHMENTS

Completion of project 2010-04: RWIS Sensor Density and Location

MDOT is looking to expand their RWIS system and this information will be distributed to the areas within MDOT that will be placing new installations in 2017.

Completion of project 2012-05: Seasonal Weight Restrictions Demonstration, Phase 1. MDOT participated to develop a project to evaluate existing data available, collect additional data, and determine models that can be analyzed to predict spring thaw.

Arizona and Delaware have joined the Aurora group.

FISCAL YEAR 2017 ACCOMPLISHMENTS

2017 National Winter Maintenance Peer Exchange – Completed September 2017. The National Winter Maintenance Peer Exchange (NWMPE) is the premier forum for winter maintenance professionals to learn about the state of the practice and state of the art in winter maintenance. The forum is held every other year and is co-sponsored by Aurora, Clear Roads, and AASHTO's SICOP. Participants benefit in learning what the best practices are from over 30 state DOTs who showcase their work in winter maintenance. Breakout sessions provided the opportunity to contribute to the national winter maintenance dialogue and research agenda. The 6th National Winter Maintenance Peer Exchange was held September 12-13, 2017 in Pittsburgh, Pennsylvania.

Improving Estimations of Real-Time Traffic Speeds during Weather for Winter Performance Measurement – Completed April 2017. This project developed a model based on traffic, weather, and maintenance activity data to produce real time predictions of weather influenced traffic speed drops with uncertainty measures.

An Analysis of the PWD Precipitation Rate Estimates as Compared to a Hotplate Snow Gauge – Completed April 2017. The objectives of this project were to 1) assess sensor performance for measuring LWE under various precipitation type and temperature scenarios, 2) provide an analysis on the observed differences between the base-elevation and mid-elevation LWE, 3) develop recommendations on alternate sensors, i.e., snow depth sensor, or operational changes in determining LWE using the PWD suite of sensors.

Review Synthesis of Alternative Power Supply – Completed August 2017. This project provided a comprehensive review, investigation, and analysis of alternative power sources and power budgets of sensors and associated components for remote RWIS applications.

RWIS Training Tool – Completed September 2017. The Aurora Storm Simulator training module mimics the decisions a maintenance supervisor makes during winter storm situations. The simulator provides information about typical maintenance resources (routes, staff, equipment, materials) available at a maintenance facility and then follows how a student manages the resources during a winter event. The simulator monitors a student's level of performance over the storm scenario in three ways: costs, time (usage and regain), and an index of mobility.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Meetings and Conference Calls

- Held Spring Board Meeting in Seattle, Washington (April 10 – 12, 2018)
- Held Fall Board Meeting in Columbus, Ohio (October 16 – 18, 2018). This meeting included Friends of Aurora.
- Host(ed) monthly Aurora Board conference calls to generate research ideas and discuss important issues.

Research

- Tracked progress on three existing Aurora projects.
 - Seasonal Weight Restrictions Demonstration, Phase 2
 - RWIS Sensor Density and Location, Phase 2
 - Winter Severity Index (Support to Clear Roads)
- Developed scopes of work and tasks for two prospective Aurora projects. It is anticipated that these projects will be awarded late this quarter or early next quarter.
 - Guidelines on the use of Invasive and Non-Invasive Sensors, Phase I Existing Capabilities and Limitations
 - RWIS Life Cycle Costing
- Develop additional scopes of work for prospective research projects, based on Aurora Fall Board Meeting discussion.
- Finalized three research project reports.
 - Seasonal Weight Restrictions Demonstration, Phase 1
 - Quantifying Salt Concentration on Pavement, Phase 2
 - Survey of Best Practices in Data Storage
- Developed a relationship with the National Severe Storm Laboratory regarding advanced radar capabilities. Aurora now receives regular updates from technical staff.
- Shared research opportunities with the National Center for Atmospheric Research (NCAR).
- Investigated integration of weather, ITS and connected and autonomous vehicles with FHWA.
- Supported Pathfinder and IMO participation by Aurora members.
- Provide access to, and support of, the Aurora Storm Simulation Training Program (<http://aurorabase.iteris.com/login/?destination=/>). This tool provides customized snowplow training based on actual weather and storm simulation, including organizing labor and equipment. A grade is provided to each student.

Outreach and Membership

- New membership: State of Washington, State of Missouri (anticipated)
- Provide Aurora Pooled Fund updates at various meetings.
- Aurora members completed multiple SICOP Talks Winter Ops podcasts.
- Presented at FHWA National Road Weather Stakeholders meeting.
- Presented at Transportation Research Board (TRB) AH010 Surface Transportation Weather Committee and AHD65 Winter Maintenance Committee.
- Engaged with industry, i.e. probe data providers, considering weather research opportunities and understanding the capabilities of new technologies.
- Engaged with weather research industry (vendors and manufactures) to understand new trends, technology and solving equipment limitations and issues. This is accomplished through the Friends of Aurora event. Engagement with industry provides the opportunity to understand state issues and discuss trends and new capabilities within industry. Aurora provides this opportunity every other year.

- Roemer Alfelro is the FHWA liaison to Aurora. He is actively engaged with Aurora members, providing members with the latest FHWA resources, programs and committee membership opportunities. This keeps Aurora members aware of federal road weather management direction and opportunities, including integration with connected and autonomous vehicles.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Meetings and Conference Calls

- Held Spring Board Meeting in San Diego, California (March 26-28)
- Held Fall Board Meeting in Tampa, Florida (October 8-10, 2018)
- Host(ed) monthly Aurora Board conference calls to generate research ideas and discuss important issues.

Research Completed/In Progress:

Optimal RWIS Sensor Density and Location - Phase III

- Utilize select interstate highways of Iowa since applicants have already archived stationary RWIS datasets and imagery, and other remote sensing and GIS data in previous projects. In addition, the key variables of interest in this project will be road surface index (RSI) and road surface temperature (RST). RSI is considered one of the most important performance indicators as it measures the effect of various winter maintenance operations on road users (i.e., level of service). RST has been selected for investigation as it is required to generate accurate road weather forecasts and predicting black-ice potential.
- Using knowledge gained and methods developed from this project, additional efforts can be made via an extended research opportunity to implement larger case-studies and provide winter maintenance personnel with a visualization tool that they need to help make more informed decisions on optimizing the use of existing infrastructures and available resources while improving mobility and safety of motorists.

Invasive and Non-Invasive Sensing: Assessing Agreement between Measurement Systems (To be completed by Fall 2020)

- The objectives of this effort are to: 1) Develop location and density optimization models and solutions for all other members of AURORA that were not covered in our previous project; 2) Extend the methodology to account both spatial and temporal attributes of road weather and surface conditions; 3) Develop an empirical optimal density model and related guidelines based on results for all topographic-climate zones in central North America; 4) Evaluate the effects of spatial demarcation on RWIS planning, and examine the implications of RWIS deployment at different geographical/jurisdictional levels (e.g., leveraging the RWIS stations in neighbor states/provinces); and 5) Integrate the developed solutions into LORWIS (www.lorwis.com) – a prototype web-based RWIS location visualization platform for demonstrating the proposed models and the resulting solutions.

RWIS Sensor Density and Location, Phase 2

- The objectives of this effort are to: 1) Develop location and density optimization models and solutions for all other members of AURORA that were not covered in our previous project; 2) Extend the methodology to account both spatial and temporal attributes of road weather and surface conditions; 3) Develop an empirical optimal density model and related guidelines based on results for all topographic-climate zones in central North America; 4) Evaluate the effects of spatial demarcation on RWIS planning, and examine the implications of RWIS deployment at different geographical/jurisdictional levels (e.g., leveraging the RWIS stations in neighbor states/provinces); and 5) Integrate the developed solutions into LORWIS (www.lorwis.com) – a prototype web-based RWIS location visualization platform for demonstrating the proposed models and the resulting solutions.

Road Authority Practices in Data Storage Survey(Completed)

- Road authorities across the United States of America, Canada, and some European organizations regarding their data collection practices for road weather information systems (RWIS), automated vehicle location (AVL) / global positioning systems (GPS), camera images, and traffic data. The results of this survey can be used by Aurora members to assess their data collection practices with respect to other road authorities.

Seasonal Weight Restrictions Demonstrations, Phase 2 (In Progress until Spring 2021)

- The major task of Phase 2 was to implement the suite of models recommended from Phase 1 at the demonstration sites, and to calibrate those models, if required. Output from those models was then compared with validation data. Validation data, provided by the DOTs, consisted of subsurface temperature data (which was reduced by the research team to compute frost and thaw depths), and in some cases, deflection and/or stiffness data from LWD and FWD tests. The following SLR protocols and models were originally planned for implementation during the 2014-2015 and 2015-2016 winter/spring: 1) Degree day threshold models; 2) Frost & Thaw Depth Prediction Models (freeze thaw index); 3) Frost & Thaw Depth Prediction: Numerical Model.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Aurora is an international partnership of public road agencies working together to perform joint road weather research. By participating MDOT is able to help set the agenda for collaborative research, development, and deployment of road weather information systems (RWIS), multiply our financial resources to address its most pressing RWIS-related challenges and to develop relationships with national and international, public and private leaders in RWIS equipment, decision support systems, standards, and training.

MDOT has fulfilled its total pledge contribution amount and project completion is expected in FY 2020.

The pooled fund study has a revised completion date of December 31, 2020. Research Administration plan to initiate briefing meetings with the MDOT Technical Contact [TC] and the appropriate RAC chair/FAM to discuss steps to review project products/deliverables and whether an implementation action can be developed at MDOT. If so, the MDOT TC will need to develop a draft IAP plan for the RAC to recommend review/approval by MDOT Research Executive Committee, before a Final IAP is implemented. Going forward MDOT has joined TPF-5(435) FY's 2020-2024 \$25k each fiscal year.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE:

Improving Specifications to Resist Frost Damage in Modern Concrete Mixtures

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(297)	MDOT START DATE	1/10/2014
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/1/2019
OR NO.	OR14-038	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Tim Stallard, 517-322-6448 StallardT@michigan.gov		
LEAD AGENCY:	Oklahoma Department of Transportation		
PROJECT MANAGER	Ron Curb, 405-522-3795 rcurb@odot.org		
CONTRACTOR			

BUDGET STATUS

FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$17,500.00	TOTAL BUDGET	(Original)	\$70,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$17,500.00	TOTAL COMMITTED FUNDS AVAILABLE		\$0.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

CT, IA, ID, IL, IN, KS, MI, MN, ND, NE, OK, PA, WI

PURPOSE AND SCOPE

The purpose of this project is to establish new test methods and specifications for fresh and hardened concrete to determine frost durability and field performance.

Task 1: Literature Review and Development of the Testing Matrix

Task 2: Sample Preparation

Task 3: Validation of the Super Air Meter (SAM)

Task 4: Use of X-Ray Tomography of Air Voids and Frost Damage

Task 5: ASTM C 666

Task 6: Absorption and Desorption

Task 7: Degree of Saturation and Damage Development

Task 8: Rate of Damage Analysis

Task 9: Technology Transfer

Task 10: Final Report

FISCAL YEAR 2014 ACCOMPLISHMENTS

Literature Review and Development of the Testing Matrix, 50% complete.

Samples will be prepared at Oklahoma State University (OSU) and a subset of these mixtures will be prepared at a local ready-mix plant to replicate these mixtures in the field, 10% complete.

Validation of the Super Air Meter (SAM), 20% complete.

Creation of an AASHTO Test Method and Specification for the Super Air Meter (SAM), 35% complete.

Degree of Saturation and Damage Development, 10% complete.

FISCAL YEAR 2015 ACCOMPLISHMENTS

Literature review and development of the testing matrix is 88% complete. Over 80 mix designs have been investigated. Preparation of lab mixes for evaluation at OSU is 45% complete. Validation of the SAM is 50% complete. Creation of an AASHTO test method for the SAM test is 70% complete. X-ray tomography of air voids and frost damage is 33% complete. Comparison of ASTM C666 freeze thaw durability testing with SAM results is 45% complete. Absorption and desorption testing is 50% complete. Determination of damage development vs. degree of saturation is 60% complete.

FISCAL YEAR 2016 ACCOMPLISHMENTS

As of September 30, 2016: literature review was 95% complete. Sample preparation was 85% complete. Validation of the SAM was 85% complete and included a round robin testing cycle. Creation of an AASHTO test method was 90% complete. Investigation of moisture penetration was 75% percent. ASTM C666 testing was 85% complete. Absorption and desorption investigation was 85% complete. Degree of saturation and damage investigation was 90% complete. Rate of damage examination was 50% complete. Tech transfer was 80% complete and included a webinar at the end of September to present the latest information. The final report was 15% complete.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Task 1 – Continued Development of the Super Air Meter [SAM]

- A new O-ring that can bridge over sand grains and better seal the lid of the meter has been developed and produced on a large scale.
- A new gauge has been developed that is reinforced.
- A preliminary precision and bias statement has been developed by using two different SAM testers and over 158 different concrete mixtures.
- Work is also being done to update the AASHTO TP 118 test method for the SAM.

Task 2 – Investigate field construction practices and aid SAM adoption

- Field and lab test data from the participating DOTs has been compiled.
- The impact of pumping concrete on the air system quality has been studied.
- The effect of falling height and vibration is being investigated.

Task 3 – Standardizing a new rapid freeze thaw test

- A test method has been developed to measure critical saturation.
- ASTM C1585 model has been modified and used to develop the matrix saturation and the secondary rate of absorption.
- A number of concrete mixtures have been created at Oklahoma State with different w/cm and air void contents and qualities.
- The conditioning and testing of the samples at Oregon State have begun.

Task 4 – Measuring different FT exposure conditions

- The data loggers to measure this have been constructed and the measurement in concrete is being finalized.

Task 6 - Confirmation of FT results with X-ray and neutron imaging

- Both research groups on this project have been studying the movement of water with both X-ray and neutron tomography and radiography.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Task 1 – Continued Development of the Super Air Meter [SAM]

- Work continuation on a precision and bias statement.
- The major proposed change to AASHTO TP 118 is to remove the use of a concrete vibrator for consolidation.

Task 2 – Investigate field construction practices and aid SAM adoption

- A report has been produced with details of the impact of pumping concrete on its air void system
- Both laboratory and field tests show that the air void system of pumped concrete coarsens and that sometimes there is dissolution of the air content.
- Despite coarsening of the air void system and, typically, a loss of air content, pumped concrete did not show poor freeze thaw behavior.
- This air void loss has resulted in measured air content as low as 2%, with the concrete still having acceptable freeze thaw durability. This implies that the dissolved air will return to the concrete, and the implication is being confirmed with hardened air void analysis.
- It has been proposed that concrete only be tested before the pump, and not after the pump.
- Testing on the impact of drop height shows that there is little loss of air content or impact on the SAM number for falls of 10 feet or less. Greater heights results in greater change to air void system.

Task 3 – Standardizing a new rapid freeze thaw test

- Modifications have been made to ASTM C1585 and compared to results from ASTM C666.
- 30 mixtures have been tested, broken into 3 water-to-cement ratios and 4 – 6 different air contents.
- Porosity, formation factor, and bucket tests have been performed on these mixtures.

Task 4 – Measuring different FT exposure conditions

- Laboratory tests are ongoing and samples have been placed in the field.

Task 6 - Confirmation of FT results with X-ray and neutron imaging

- X-ray and neutron imaging work well to study freeze-thaw damage within concrete
- A paper on neutron radiography has been produced that examines fluid absorption in mortar samples with varying water-to-cement ratios and preconditioning.
- Sample of concrete mixtures were cut and preconditioned to test them using neutron radiography.
- This neutron radiography study will determine if a substantial time savings in sample prep and testing is feasible.

FISCAL YEAR 2019 PROPOSED ACCOMPLISHMENTS

The team is continuing to evaluate methods to improve the SAM. Using the SAM to investigate field concrete through pumping, vibration, drop height, and mixing. The modified ASTM C1585 model (Bucket Test) is being evaluated and improved. Created an AASHTO test method for this work and start a testing round robin. Incorporated drying, wetting, salts, and differing temperature ranges into the modelling of different freeze-thaw exposure conditions. Examined pore infilling and its role in altering the overall freeze thaw performance. Also produced online video content for the Super Air Meter.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Additional states have joined the project and supplied more money than was in the original budget. This additional funding will specifically examine pore infilling and its role in altering the overall freeze thaw performance. Work will also be done to produce more online video content over the Super Air Meter.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

To date, MDOT has recognized the SAM for consideration as a next generation durability-based concrete field- testing device. Through the recent Roads Innovation Task Force (RITF), the SAM will be included in a QC shadow testing capacity for the 30- and 50-year design life concrete pavement demonstration projects, which are programmed for 2017 and 2018, respectively. Further, MDOT has recently applied for a STIC grant, which, if approved, will provide funding to purchase 8 SAMs along with resources for training and specification development.

A recent TPF solicitation (1439) titled "Performance Engineered Concrete Paving Mixtures (PEM)" has been posted, which includes a component for continuing research and development of the SAM technology. MDOT will consider the deliverables from TPF-5(297) to decide whether to (1) participate in this upcoming PEM project and if so, (2) promote awareness of lessons learned from TPF-5(297) to bolster the quality of the future PEM initiative.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Regional and National Implementation and Coordination of Mechanistic-Empirical (ME) Design

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(305)	MDOT START DATE	10/1/2016
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/30/2019
OR NO.	OR18-006	COMPLETION DATE (Revised)	9/30/2021
MDOT TECHNICAL CONTACT	Justin Schenkel 517-636-6006 SchenkelJ@michigan.gov		
LEAD AGENCY:	FHWA		
PROJECT MANAGER	Chris Wagner, 404-562-3693 christopher.wagner@dot.gov		
CONTRACTOR			

BUDGET STATUS					
FY 2019 Budget			Total Budget		
FY FUNDS	(Original)	\$0.00	TOTAL COST	(Original)	\$20,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$0.00	Total Committed Funds Available		\$0.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

Manitoba Transportation, AL, AZ, CA, CO, FHWA, FL, IA, KS, KY, MDOT SHA, MI, MO, NC, ND, NV, Ontario MOT, PA, SC, VA, WI

PURPOSE AND SCOPE

The purpose of the peer exchanges and the AASHTO National Users Group meeting is to support State DOT and Canadian province implementation of ME Design procedures by (1) sharing information between, (2) identifying issues at the local/regional level with regard to implementation, (3) identifying needs or areas that still need to be researched relative to the MEPDG, and (4) organizing implementation efforts on a regional and National basis.

The four peer exchanges will be limited to participation by governmental agencies, while the AASHTO Users group meeting will be open to industry representatives, academics, consultants, and others interested in ME Design. Funds from this pooled fund will only be used to support contributing agency travel and development activities. The peer exchanges and AASHTO National Users Group meeting will focus primarily on the efforts related to the AASHTO MEPDG and related Pavement ME Design™ software. However, all agencies are welcome to participate in the pooled fund; as most topics covered are fundamental and applicable to all ME design procedures and pavement design in general.

This pooled fund will include the following tasks:

- Conduct 4 regional peer exchanges in each of the 4 AASHTO regions each year.
- Conduct 1 National AASHTO Users Group meeting each year.
- Provide funding for travel for 2 representatives from each participating agency to one regional meeting and the National AASHTO Users Group meeting.
- Provide contract support for meeting logistics and documentation of outcomes.
- Develop regionally and nationally significant products that aid MEPDG implementation including technical briefs, synthesis of best practices, updates of MEPDG documentation.
- Formation of TAC to select and approve topics to be funded.
- Develop a charter to define the governance structure of the regional groups and AASHTO Users Group and expenditures from the pooled fund.

FISCAL YEAR 2017 ACCOMPLISHMENTS

A two-day conference was held on December 14 and 15, 2016, in Indianapolis, Indiana. A report on the conference was issued that included the results from a pre-conference survey, general summaries of the different sessions, summaries of participant's presentations, and the results of a post-conference survey of meeting participants. The appendices to the report included a listing of all meeting participants as well as the full presentations that were given at the conference.

FISCAL YEAR 2018 ACCOMPLISHMENTS

According to the 3rd quarterly report of 2018, forty-three percent [43 %] of the project work has been completed.

The national conference was held on October 11 and 12, 2017, in the Denver, Colorado area. Two pavement professionals from the Pavement Management Section attended. A technical summary report of the conference proceedings was produced.

FISCAL YEAR 2019 ACCOMPLISHMENTS

A national two-day conference was held on November 7 and 8, 2018, in Nashville, TN.

PROPOSED FISCAL YEAR 2020 ACTIVITIES

An AASHTO Pavement ME Users Group Meeting is planned for November 2019 in New Orleans, LA.
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JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
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None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MDOT will remain as an active state partner until all project objectives/major tasks activities are completed and final deliverables are submitted/approved.
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**RESEARCH ADMINISTRATION
TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Technology Transfer Concrete Consortium (TTCC) [Old: TPF-5(159)]

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(313)	MDOT START DATE	4/10/2015
PROJECT NO.		MDOT COMPLETION DATE (Original)	12/31/2020
OR NO.	OR15-002	COMPLETION DATE (Revised)	03/31/2021
TECHNICAL CONTACT	John Staton, 517-322-5701 StatonJ@michigan.gov		
LEAD AGENCY	Iowa Department of Transportation		
PROJECT MANAGER	Khyle Clute, 515-239-1646 Khyle.Clute@iowadot.us		
CONTRACTOR	Iowa State University (PI-Tom Cackler)		

BUDGET STATUS

FY 2019 Budget			Total Budget		
FY FUNDS	(Original)	\$12,000.00	TOTAL COST	(Original)	\$60,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$12,000.00	Total Committed Funds Available		\$12,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

AL, CA, CO, FL, GA, ID, IL, IN, IA, KS, LA, MI, MN, MO, MT, NE, NV, NY, NC, ND, OH, OK, PA, RI, SD, TN, TX, UT, WA, and WI.

PURPOSE AND SCOPE

The purpose of this pooled fund project is to identify, support, facilitate, and fund concrete research and technology transfer initiatives. This pooled fund project allows for state representatives to continue the collaborative efforts of TPF-5(159) that originally began in TPF-5(066) Materials and Construction Optimization. The Technology Transfer Concrete Consortium (TTCC) is open to any state agency desiring to be a part of new developments in concrete. TTCC will meet in conjunction with the National Concrete Consortium (NCC), twice a year. NCC Bylaws and the Executive Committee membership can be found at <http://www.cptechcenter.org/ncc/TTCC-NCCMeetings.cfm>.

FISCAL YEAR 2010 ACCOMPLISHMENTS

The fall 2009 meeting of the National Concrete Consortium (NCC) was held in St Louis, Missouri. The theme for this meeting was Cement Standards and Technology for Sustainable Concrete Paving and included a tour of the new Holcim Cement Plant. Approximately 80 participants from government agencies, industry, and academia, including 20 different state DOT representatives, attended. The Spring 2010 workshop was held in Savannah, GA with 85 participants. The theme for this meeting was overlays, including state reports on overlays and the new roller compacted concrete guide.

FISCAL YEAR 2011 ACCOMPLISHMENTS

The Spring 2011 workshop was held in April 2011 in Indianapolis, IN. Approximately 80 participants from government agencies, industry, and academia, including 20 different state DOT representatives, attended. The Fall 2011 workshop was held in Rapid City, SD with approx. 85 participants. The theme for this meeting was the Mechanistic-Empirical Pavement Design Guide, including state reports.

FISCAL YEAR 2012 ACCOMPLISHMENTS

The Spring 2012 NCC meeting was held in Oklahoma City, OK. The theme for this meeting was non-destructive testing of concrete. The fall meeting was held in Seattle, WA, in conjunction with the International Conference on Concrete Pavements. This NCC meeting provided updates on several pooled fund projects related to Task 1 of the current CP Roadmap. There were also discussions relative to a proposed future pooled fund project focused on the development of new protocol for durability-based testing and acceptance of concrete. This initiative will be further discussed in future meetings.

FISCAL YEAR 2013 ACCOMPLISHMENTS

The Spring 2013 NCC meeting was held in Philadelphia, PA. The theme for this meeting was pavement smoothness and ride quality. The fall meeting was held in Asheville, NC. Its theme was life-cycle cost and pavement type selection. This NCC meeting provided updates on several pooled fund projects related to Task 1 of the current CP Roadmap. There were also discussions relative to a proposed future pooled fund project focused on development of new protocol for durability-based testing and acceptance of concrete. This initiative will be further discussed in future meetings. The total number of participating state agencies increased from 24 to 27.

FISCAL YEAR 2014 ACCOMPLISHMENTS

The Spring 2014 meeting was held in Jacksonville, FL on April 21-24. Topics included state reports, rethinking concrete delivery, a SHRP2 update, sustainability, bridge deck cracking, and others. The Fall 2014 meeting was held in Omaha, Nebraska on September 9-11. Topics included state reports on aggregate quality, MnRoad update, Microspheres, Quality paving, FHWA Update, pavement repairs, and others.

FISCAL YEAR 2015 ACCOMPLISHMENTS

The Spring 2015 meeting was held in Reno, NV on April 21-24. Topics included state reports on concrete curing, internal curing, performance-based durability specifications, and others. The Fall 2015 meeting will be held in Milwaukee, WI on September 15-17. Topics include state report on concrete pavement joint sealing practices, there were also sessions on the Super Air Meter, Formation Factor, performance engineered mixes, FHWA Update, and others.

FISCAL YEAR 2016 ACCOMPLISHMENTS

The Spring 2016 meeting was held in Columbus, OH on April 21-24. Topics included performance engineered mixes, recycled concrete aggregate, FHWA update, roller compacted concrete, self-powered sensors for concrete, UHPC, Bridge deck cracking, and internal curing. The Fall 2016 meeting was held in San Antonio, TX on August 28 - September 1. This meeting was held in conjunction with the 11th International Conference on Concrete Pavements. Topics include an update on the CP Tech Center technical products, performance engineered mix update, and state reports. In addition, each attending state DOT representative participated in the international conference by either moderating a session, presented a topic in a technical session, or presented a poster in the poster session. MDOT presented two posters; concrete surface sealers and the US-23 Aggregate Test Road.

FISCAL YEAR 2017 ACCOMPLISHMENTS

The Spring 2017 meeting was held in Salt Lake City, April 25-27. The Fall meeting was held in Minneapolis, September 19-21. Highlights of the meeting and all of the presentations can be found at: <http://www.cptechcenter.org/ncc/TTCC-NCC-2017.cfm> and <http://www.cptechcenter.org/ncc/TTCC-NCCMeetings.cfm>

FISCAL YEAR 2018 ACCOMPLISHMENTS

The spring meeting was held in Coeur d'Alene, Idaho April 24-26, 2018. The general session consisted of 23 topics presented by representatives from 5 state agencies, 3 from FHWA, 3 from academia, and 4 from the industry sector.

Fiber Reinforcement for Concrete Overlays and Bridges update:

- Completion date of December 31, 2018
- Project TAC conference calls are held to review progress
- Software tool for calculating fiber performance for concrete overlays is in progress.
- Tech Brief for FRC for concrete overlays is in progress
- Overview of FRC for bridge decks is in progress.

Meeting presentation highlights include:

- Performance Engineered Mixtures: ○ Updates from the National Concrete Pavement Technology Center,
 - TPF-5(368) Pooled fund update
 - FHWA Mobile Concrete Lab
 - Turner Fairbanks Research Center program update
 - Michigan and Idaho implementation initiatives and experiences
- Latex Modified Bridge Deck Overlays: ○ North Carolina and Missouri experiences
- Alternatives to the Traditional Way: ○ Alternate cementitious materials
 - Reclaiming coal ash from legacy ponds by a burn-out process to increase quality and quantity
 - The evolution of new test methods for transport properties of concrete and resistance to freezing and thawing. Using the bucket test to determine the formation factor.
 - Research on a new method to measure water-cement ratio of concrete and on factors to consider for formwork removal.
- NCC States report on:
 - Types of reinforcement
 - Mass concrete
 - Self-Consolidating Concrete
- Reinforcement – which one to choose
- ACI – fiber reinforced polymer specification.

Ongoing Research:

- New method to measure w/c ratio in fresh concrete
- New method to measure w/c ratio in fresh concrete
- ODOT/MnDOT formwork removal research
- Concrete in an aggressive salt environment

The fall meeting was held in Saratoga Springs, New York September 18-20, 2018.

Topics included Quality Control/Quality Assurance, Balancing Risk, NCC State Reports, Pooled Fund Update, Training Opportunities for NCC, SPS-2 Update, Determination of optimized opening using NDT, Accelerated precast concrete Pavements, etc.

FISCAL YEAR 2019 ACCOMPLISHED

The spring meeting was held in Denver, Colorado April 2-4, 2019

Meeting presentation highlights include:

- FHWA Updates, SAM PWL Analysis, Concrete PRS Shadow Project, and TFHRC Update
- PEM Update
- Hot topics in bridges
- Drilled shafts and mass concrete
- States experiences with mass concrete
- Accelerated bridge construction
- Materials
- Role of minimum cement content
- Formation factor
- Rapid repair and early loading
- Joint activation efforts in FRC and fibers in concrete
- SAM testing update

The fall meeting was held in Kalispell, Montana September 10-12, 2019

Meeting presentation highlights include:

- FHWA Updates, SAM PWL Analysis, Concrete PRS Shadow Project, and TFHRC Update
- PEM Update
- Early Opening to Traffic Technologies
- Precast concrete materials
- Precast bridge and pavement elements
- Topical treatments and repair technologies
- Dowel bars in PCC
- Innovation updates

FISCAL YEAR 2020 PROPOSED ACTIVITIES

This TPF project will closeout (estimated completion date 03/31/2021) after all deliverables, final report, and the accounting closeout spreadsheet is approved by FHWA. The collaborative efforts of this project that originally began in TPF-5(066) Materials and Construction Optimization will continue under the new TPF-5(437) federal project. Member states have pledged their contributions to the new project on the TPF website.

The Spring 2020 meeting will be held in Nashville, TN on March 31-April 2

The Fall 2020 meeting will be held in Minneapolis, MN on August 30 to September 3

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

This is a continuing pooled fund study focused on being an ongoing forum to identify, support, facilitate, and fund concrete research and technology transfer initiatives. It serves as a forum to transfer technology and current state of practice amongst participating state DOTs, industry, and academia. Discussions and dialogue presented often serve as a springboard for further in-depth studies and pooled efforts.

MDOT has pledged to contribute SPR-II federal funds through FY 2019. The lead agency current research contract with Iowa State University has been extended to December 31, 2020.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Transportation Management Center (TMC) Pooled Fund Study				[Previously SPR-2(207)]	
FUNDING SOURCE: <input checked="" type="checkbox"/> FHWA <input type="checkbox"/> OTHER (PLEASE EXPLAIN)					
TPF NO.	TPF-5(319)		MDOT START DATE (FUNDING)	4/17/2015	
PROJECT NO.			MDOT COMPL. DATE (FUNDING)	4/16/2020	
OR NO.	OR14-040		PROJ. COMPL. DATE (TPF Website)	4/16/2022	
MDOT TECHNICAL CONTACT	Suzette Peplinski, 616-451-8448 PeplinskiS@michigan.gov				
LEAD AGENCY:	Federal Highway Administration (FHWA)				
PROJECT MANAGER	Jimmy Chu, 202-366-3379 jimmy.chu@dot.gov				
CONTRACTOR					
BUDGET STATUS					
FY 2019 Budget			Total Budget		
FY FUNDS	(Original)	\$25,000.00	BUDGETED AMT.	(Original)	\$125,000.00
	(Revised)		BUDGETED AMT.	(Revised)	
TOTAL FY 2019 EXPENDITURES		\$25,000.00	Total Committed Funds Available		\$0.00
PARTICIPATING STATES					
ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.					
CA , FL , GA , IA , IL , KS , MI , MN , MO , NC , NV , NY , PA , TN , TX , UT , VA , WA , WI					
PURPOSE AND SCOPE					
The purpose of the Transportation Management Center (TMC) Pooled Fund Study is to assemble regional, state, and local transportation management agencies and the Federal Highway Administration (FHWA) to (1) identify human-centered and operational issues that are common among TMC operators and managers; (2) suggest approaches to addressing identified issues; (3) initiate and monitor projects intended to address identified issues; (4) provide guidance and recommendations and disseminate results; (5) provide leadership and coordinate with others with TMC interests; and (6) promote and facilitate technology transfer related to TMC issues nationally.					
FISCAL YEAR 2014 ACCOMPLISHMENTS					
Studies included: Best Practice for Road Condition Reporting Systems, Guidebook for Developing Virtual TMCs, Effectiveness of Safety and Public Service Announcement (PSA) messages on Dynamic Message Signs (DMS), Roles of Transportation Management Centers in Incident Management on Managed Lanes, and Travel Time Displays prior to Freeway Entrances. A webinar was also held: Effectiveness of Disseminating Traffic Messages on Dynamic Message Signs.					
FISCAL YEAR 2015 ACCOMPLISHMENTS					
Several webinars were held on current, relevant TMC topics that MDOT staff attended. Studies included: Human Factors Guidelines for TMCs, Next Generation Traveler Information System - A 5-Year Outlook Project, and Public Perception of PSA on DMS in Rural Areas.					
FISCAL YEAR 2016 ACCOMPLISHMENTS					
TMC PFS group held quarterly conference calls to share information and update on studies. Several webinars were held (which are generally done through USDOT's T3 program to share with a wider audience) on current topics. Studies completed this year include: TMC Video Recording and Archiving Best General Practice, Freeway Service Patrol Prioritization and Best Practice, and Travel Time Displays at Freeway Entrance Approaches. All three of these topics are of current relevance in Michigan and have been shared with MDOT operations stakeholders. MDOT hosted the group's Annual Meeting this year at the Southeast Michigan TOC in Detroit.					
FISCAL YEAR 2017 ACCOMPLISHMENTS					
Quarterly conference calls were held with members to review progress of studies and share information. Reports were issued for: Safety Service Patrol Prioritization and Best Practices, Synthesis of Variable Speed Limit Sign Operations, Public Perception of Public Safety Messages on DMS. Ongoing studies were initiated for the Effects of ITS Planning and Deployment in a CV Environment.					
FISCAL YEAR 2018 ACCOMPLISHMENTS					
Quarterly conference calls were held with members to review progress of studies and share information. Reports were issued for: Effects of ITS Planning and Deployment in a CV Environment and Travel Time Displays at Freeway Entrance Approaches. Ongoing work: Capability and Usage Guidelines for Color CMSs, Consideration of Current and Emerging TMC Data, IT Security Guidance for TMCs, Streaming Video Sharing and Distribution.					
FISCAL YEAR 2019 ACCOMPLISHMENTS					
Studies completed:					
<ul style="list-style-type: none"> • Consideration of Current and Emerging TMC Data • Streaming Video Sharing and Distribution 					

Studies continued:

- Capability and Usage Guidelines for Color Changeable Message Signs
- IT Security Guidance for Transportation Management Centers.

Projects that were started and kick-off meetings held in 2019:

- Use of TMC Performance Dashboards for Communicating the Benefits of Traffic Operations
- Info & Analysis of TMC Staff and Staffing Contracts
- Performance Measures & Health Index of ITS Assets

RM NOTES:

The TMC Pooled Fund Study Annual Meeting was held on May 14th & 15th of 2019 in Denver, Colorado. Members from 17 agencies participated in the meeting to share their knowledge and experience, exchange information, and select projects to advance in 2020.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Studies approved for 2020 are Synthesis of Applying Predictive Analytics for Traffic Operations, Guidelines for ITS Asset Life Cycle Cost Analysis and Planning, and Capability and Maturity Assessment of Traffic Management Systems.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

TPF website revised project completion date to April 16, 2022.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Implementation Recommendations

- MDOT staff have attended the PFS webinars (which are used to help disseminate information from each of the completed studies) and use information discussed, along with the related studies, for developing statewide guidelines and projects.
 - Links to completed studies are distributed to the ITS Stakeholder group as they are released.
 - IT Security Guidance will be helpful with the importance efforts in MDOT's partnership with DTMB to continue to improve the security of our networks and data.
 - Effects of ITS Planning and Deployment in a CV Environment was published for use in MDOT's continuing CAV efforts and implementation.
 - Multiple MDOT staff are involved in the ongoing projects to provide input and guide studies to benefit MDOT's data management, network security, operations contracting, and ITS asset management efforts.
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RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019

STUDY TITLE: Base Funding for the North Central Superpave Center

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(320)	MDOT START DATE	02/3/2015
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/30/2022
OR NO.	OR15-521	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Kevin Kennedy, 517-322-6043 KennedyK@michigan.gov		
LEAD AGENCY:	Indiana Department of Transportation		
PROJECT MANAGER	Tommy Nantung, 765-463-1521 ext. 248 tnantung@indot.in.gov		
CONTRACTOR			

BUDGET STATUS

FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$25,000.00	TOTAL BUDGET	(Original)	\$125,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$25,000.00	TOTAL COMMITTED FUNDS AVAILABLE**		\$0.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

IA, IL, IN, KS, MI, MO, and WI

PURPOSE AND SCOPE

This pooled fund project will provide for continued operation of the North Central Superpave Center (NCSC) to assist agencies and industry with Superpave implementation and hot mix asphalt issues. The NCSC will provide technical assistance, training, communication, and research and development to meet the needs of the region.

FISCAL YEAR 2015 ACCOMPLISHMENTS

There was a conference held in 2015 prior to MDOT committing funds. Planning for the 2016 conference is ongoing. A teleconference was held to discuss states' experience with premature cracking on Hot Mix Asphalt (HMA). Additional technical conference calls will be held throughout the coming year.

FISCAL YEAR 2016 ACCOMPLISHMENTS

A teleconference was held in February to discuss asphalt performance testing/balanced mix design. The 2016 technical conference was held in March in Indianapolis. Topics discussed include fundamentals of recycled shingles, rejuvenators, softening agents, REOB, durability, construction related items, verification of specific gravity, and various FHWA policies (current and future). Learning the state of the practice will help MDOT remain current with specifications and compliant with federal regulations. The NCSC will provide technical assistance, training, communication, and research and development work to meet the needs of the region.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Work continued on the study Tack Coat Installation Performance Guidelines.
Testing continued on an industry-supported project- Determining the Fiber Content in Crack Sealing. A presentation on the proposed method was given to the ASTM Subcommittee on Formed In-Place Sealants and Cracks in Pavements.
The subcommittee expressed interest in seeing more results and will consider adopting the test as a new ASTM standard.
Work continued on the study Development of a Friction Performance Test for Compacted Asphalt Mixtures. Proof of concept testing is underway and looks promising. A Study Advisory Committee meeting was held in early July.
Testing of Reclaimed Asphalt Pavement (RAP) samples for the study Investigation of Delta Tc for Implementation in Indiana is underway along with a comprehensive literature review. Seven virgin binders have been tested after 20-hr and 40-hr Pressure Aging Vessel (PAV) aging. One source of shingles has been obtained for testing. A Study Advisory Committee meeting was held in early July to get input on which blends to continue testing.
Survey responses are being analyzed and the literature review is continuing for the study Best Practices for Patching Composite Pavements. A SAC meeting was held in early July.
Technology Transfer-The Technical Director participated in the TRB workshop on implementation of Warm Mix Asphalt. Concerns exist on why some states are lagging behind in May 2017. She attended the FHWA Asphalt Mix and Binder Expert Task Group meetings in May as well. She also participated in the ASTM Road and Paving Material committee week as Vice Chair.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Communication:

Information requests were processed as they arrived. Approximately 20-25 requests were received per month. Published reports have now been downloaded from the Joint Transportation Research Program website. During this calendar year there have been over 10,700 occurrences.

Third Party Lab and Testing Services:

Proficiency testing continued. Maintenance of the AMRL accreditation records. The AASHTO Resource lab inspection was completed. Samples for third party tack coat bond strength and ITM 221 (friction) testing were received and testing completed. Samples for dynamic modulus testing were received from Penn State University; their equipment broke near the end of a research project. The Nova Scotia Transportation ministry requested a review of their Superpave asphalt specifications and tests.

Research:

Continue to work on the study *Tack Coat Installation Performance Guidelines*. Testing has been completed and the data analysis is underway. A draft final report is anticipated in July 2019.

Continue to work on the *Development of a Friction Performance Test for Compacted Asphalt Mixtures*. Testing has been completed and a draft final report will be submitted next quarter.

Testing continued for *Investigation of Delta Tc for Implementation in Indiana* and data analysis is underway. The draft final report will be completed next quarter or early in the following quarter.

A time extension was requested for *Best Practices for Patching Composite Pavements* to allow time to collaborate with an INDOT engineer who will be working on this issue. The Study Advisory Committee approved the request, which was forwarded through the appropriate channels.

Work on *Real Life Experiences with Major Pavement Types* was initiated. A literature review to identify possible analysis techniques, data elements needed for life cycle cost analysis and other background information began. Past JTRP research reports and the Indiana LTPP sites were reviewed to see if any previously studied test sites could be used in this study.

Continue to work on an NCHRP Synthesis study on asphalt pavement lift thicknesses. Survey responses were received from 45 states, five provinces and 62 industry representatives. The first draft report was submitted. A panel meeting to review the report will be held early next quarter.

Technology Transfer:

The Technical Director participated in the meeting of the TRB committee on Critical and Emerging Issues in Asphalt Technology. She gave a presentation on research at the NCSC at ASCE Indiana Section Annual Meeting and represented the region at the ASTM International's Committee on Road and Paving Materials.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Training:

The technical director provided a Perpetual Pavements webinar over the Upper Great Plains Transportation Institute's (North Dakota State University) distance learning system to participants in three states. She also gave a shorter presentation at the ND Asphalt Conference. She provided over one day of training on asphalt materials, construction and Superpave5 to approximately 20 engineers and managers from INDOT.

Communication:

Information requests are processed as they arrive; about 20-25 per month are received. Minutes and presentations from the last Multi-Regional Training and Certification Group (M-TRAC) meeting were posted and NCSC staff is exploring ways to facilitate asking questions and sharing responses for the group. Published reports have now been downloaded from the Joint Transportation Research Program website over 11,930 times.

Third Party Lab and Testing Services:

The research engineer continued her work on proficiency testing and maintenance of AMRL accreditation records. The internal lab audit was completed. Lab usage fees were established for third-party testing and are included in the new lease agreement between Purdue and INDOT.

Research:

The draft and final reports for *Investigation of Delta Tc for Implementation in Indiana* were completed this quarter and the close-out meeting was held. A draft implementation plan was provided to the business owner; implementation of the parameter is not recommended at this time. It could possibly be used as a forensics tool or could be implemented in the future after some remaining issues are resolved nationally. Publication of the final report is expected next quarter.

Work on *Real Life Experiences with Major Pavement Types* continued. A literature review to identify possible analysis techniques, data elements needed for life cycle cost analysis and other background information continued.

The final report on an NCHRP Synthesis study on asphalt pavement lift thicknesses was published by TRB.

Technology Transfer:

The Technical Director and Jusang Lee gave a presentation about the Superpave Center and partnership with INDOT and other states to a delegation of Korean engineers who were visiting ASTM Headquarters. The technical director participated in her first ASTM Board of Directors' Meeting of her three-year appointment. She also chaired the meeting of ASTM Committee D04 on Road and Paving Materials. She delivered the Gene Skok lecture at the National Road Research Alliance meeting in May. She also participated in the meeting of TRB Committee AFK10, Critical and Emerging Technologies in Asphalt, as Asphalt Section chair. This two-day meeting was held in Indianapolis and

included invited guests from Indiana, Illinois, Michigan and Ohio industry and agencies in addition to the committee members. Negotiations began to partner with the Asphalt Pavement Alliance to co-host the NCAUPG meeting.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Training:

Training will be developed and provided as requested.

Communication:

Updates to the NCSC and NCAUPG websites will be posted. Information requests will be answered as received.

Third Party Lab and Testing Services:

Continue work on maintaining the AMRL accreditation records and continue third party testing as requested.

Research:

Work will continue as planned on the research projects. Identify new research needs and prepare proposals as appropriate.

Technology Transfer:

Additional opportunities for tech transfer will be pursued as they become available.

NCAUPG Meeting:

Work is being done to have a 2020 meeting with help from the Asphalt Pavement Alliance

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

MDOT has fulfilled its total pledge contribution amount. The revised completion date on the TPF website is September 30, 2022 and no additional funds have been requested.

MDOT pledged commitments for fiscal years 2015 and 2016 [\$25k each] was transferred during FY 2016 to the lead state. As such, the original FY 2015 commitment was changed to \$0.00 and the FY 2016 was revised from \$25,000.00 to \$50,000.00 on the TPF website.

MDOT has posted its FY's 2018 and 2019 pledge amounts to the TPF website.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2022.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: No Boundaries Roadway Maintenance Practices

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(330)	MDOT START DATE	5/29/2015
PROJECT NO.		MDOT COMPLETION DATE (Original)	6/30/2019
OR NO.	OR15-518	COMPLETION DATE (Revised)	9/30/2020
MDOT TECHNICAL CONTACT	Tim Croze, 517-243-5977 CrozeT@michigan.gov		
LEAD AGENCY:	Ohio Department of Transportation		
PROJECT MANAGER	Cynthia Jones, 614-466-1975 cynthia.jones@dot.ohio.gov		
CONTRACTOR			

BUDGET STATUS

FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$10,000.00	TOTAL BUDGET	(Original)	\$30,000.00
	(Revised)			(Revised)	\$40,000.00
TOTAL FY 2019 EXPENDITURES		\$0.00	TOTAL COMMITTED FUNDS AVAILABLE		\$0.00

PARTICIPATING STATES

CT, FL, IL, LA, MD, MI, MN, MO, NY, ND, OH, PA, SC, VA, WA, & WI

PURPOSE AND SCOPE

This project provides a forum for state DOTs to share their maintenance innovations (non-winter) with each other, support technology transfer activities and develop marketing and deployment plans for the implementation of selected innovations. The goal of this consortium is to become the premier national forum for technical exchange and collaboration related to the application of new maintenance initiatives, research and technologies.

This project will help DOTs to save time and money by not investing in the same research that has already been performed by other state DOTs. Hence rather than having each DOT identify and implement research separately, DOTs can work collectively through this pooled fund project.

Scope of Work:

- 1) Identify promising innovations and technologies ready for implementation within maintenance activities, developed by the participating state DOTs, non-participating DOTs and outside entities.
- 2) Develop marketing plans for selected ready-to-deploy innovations and technologies.
- 3) Organize training classes and pilot demonstrations about specific research topics or technologies for member state DOTs.
- 4) Develop a searchable database where innovations and research projects developed across the country can be identified and accessed.

FISCAL YEAR 2015 ACCOMPLISHMENTS

MDOT joined the pooled fund and are just beginning to get involved in pooled fund activities.

FISCAL YEAR 2016 ACCOMPLISHMENTS

Transportation Advisory Committee (TAC) held five (5) teleconferences on the following dates in FY 2016; 10/1/15, 11/9/15, 2/8/16, 3/31/16 and 6/1/16. One (1) face-to-face TAC meeting was held on December 10-11, 2015 in St. Louis, MO. Maintenance innovations selected by the TAC as being worthy of implementation were discussed. Planning of the next face-to-face TAC to be held on October 25-27, 2016, in Ann Arbor, MI has taken place. During the fiscal year the researcher developed an innovations submissions form and database for the No Boundaries website. All posted website maintenance innovations were entered into the new database. Based on TAC member feedback the innovation submission form was revised. Substantial updates to the No Boundaries website were made including new sections for asset management, maintenance management, member's login, and roadway maintenance e-news. A YouTube channel to feature videos of members' maintenance innovations was created.

The vendor compiled recent research and state practices to highlight in the March, April, June, and August newsletters and wrote articles about new No Boundaries resources and activities. They distributed the newsletters to TAC members and encouraged other maintenance professionals to subscribe through email and phone outreach. The vendor also conducted a national survey on asset management.

To support membership and recruitment; the vendor updated the No Boundaries handout, created presentation materials for use by ODOT at the May APWA North American Snow Conference, and provided talking points and updated handouts for use by ODOT at the June National Equipment Fleet Management Conference. Several new states joined No Boundaries throughout the fiscal year; thus,

increasing membership to 14 states. They also created and promoted a Google Group listserv to encourage information sharing among non-winter maintenance professionals.

FISCAL YEAR 2017 ACCOMPLISHMENTS

- Transportation Advisory Committee (TAC) held three (3) teleconferences on the following dates in FY 2017; 01/23/2017, 03/01/2017, 05/31/2017 and has one planned on 11/09/2017.
- One (1) face-to-face TAC meeting was held during the following dates: 08/28/2017 – 08/31/2017 in Columbus OH. Presentations on the Transportation Asset Management System (TAMS) and Transportation Systems Management and Operations (TSMO) were given from Ohio, Washington, Michigan, Minnesota, Louisiana, Washington, Tennessee and Virginia. Invited guest from Manitoba Infrastructure and Tennessee were also in attendance to learn more of what No Boundaries has to offer their programs.
- Other highlights from the 2017 "Face to Face" include attending Ohio DOT's "Team Up" innovations and showcase rodeo. Ohio, Washington, Minnesota and Louisiana presented on their innovation programs.

More No Boundaries information can be found in the September Newsletter-link below:

<http://noboundaries-roadmaintenance.org/roadway-maintenance-news-september-2017.html>

- The "Face to Face" meeting also featured several maintenance-related field trips in the greater Columbus area:
 - Time on the floor at Ohio DOT's "Team Up ODOT" innovations fair.
 - A walking tour of the aircraft hangar for the Ohio State Highway Patrol and Ohio Department of Natural Resources, located at Ohio State University Airport.
 - A driving tour of the Transportation Research Center Inc., the largest independent vehicle test facility and proving grounds in the United States.
 - A field visit to Ohio State University's Gwynne Conservation Area and Research Center, part of the Ohio Pollinator Habitat Initiative.
 - Ohio DOT Statewide Traffic Management Center located at the central office.

FISCAL YEAR 2018 ACCOMPLISHMENTS

- Organized and conducted two No Boundaries peer exchange meetings. These meetings allow member agencies to engage in one-on-one technology transfer activities and share best practices to foster better and more efficient maintenance operations and management at their home agencies.
 - April 2018, Seattle, Washington.
 - Presentations and round-table discussions addressed pollinators, maintenance asset management, silica dust exposure, roadways surface treatments, maintenance innovations, and agency program updates.
 - The meeting also featured maintenance-related technical tours of the State Route 520 floating pontoon bridge and Alaskan Way (State Route 99) tunnel construction.
 - October 2018, Austin, Texas
 - Presentations and round-table discussions addressed asset management programs, training and apprenticeship programs, unmanned aerial vehicles (drones), horizontal alignment warning signs, and adopt-a-highway program.
 - Technical visits included a tour of the fleet shop where Texas DOT fabricates maintenance vehicles (such as herbicide trucks and sign trucks) and a demonstration of the agency's pavement management information system.
- Redesigned the No Boundaries website (maintainroads.org). Retooled and relaunched the innovation database hosted on the No Boundaries' website.
- Published six bimonthly newsletters (January, March, May, July, September, and November [forthcoming]) featuring the latest updates on the group's activities and compiling recent research, state practices, and training opportunities related to non-winter roadway maintenance from around the country.
- Conducted an inquiry of No Boundaries member states regarding innovation programs and drafted a report summarizing and synthesizing findings.
- Presented to several TRB maintenance committees at the 2018 TRB annual meeting summarizing No Boundaries' activities and seeking new partners.
- Organized a 2019 TRB Annual meeting lectern session titled, "State DOT Innovation Programs: Identifying New Technologies and Practices from the Front Lines." An outline and summary were developed, and speakers were identified.

FISCAL YEAR 2019 ACCOMPLISHMENTS

- Schedule and host two face to face meetings in member states. Specific locations are yet to be determined.
- Host quarterly conference calls with group to discuss state innovations and best practices.
- Publish bimonthly newsletters featuring the latest updates on the group's activities and member states research.
- Conduct surveys and inquiries of member states as topics of interest to the group come up.
- Host 2019 TRB annual meeting lectern session titled, "State DOT Innovation Programs: Identifying New Technologies and Practices from the Front Lines." Developed a summary and outline, and speakers were also identified.

As of June 30, 2019: Project was a 64% completion by work.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

MDOT's original fund commitment was \$10k each for FY's 2015-2017. MDOT's fiscal year's 2015 fund commitment did not process in FMIS until FY 2016; due to the FYE financial system shutdown. In FY 2016 MDOT requested a fund transfer of \$50k in error to Ohio

DOT. The lead agency refunded \$20k back to MDOT. Thus, through FY 2016 a total of \$30k has been transferred to the lead agency. MDOT increased its federal fund pledge contribution by \$10,000 for fiscal year 2018.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

For fiscal year 2020 MDOT joined the new pooled fund project TPF-5(441); which is a continuation of the current TPF-5(330) federal project.

- Networking and collaboration with others DOT's.
- Clearing house for process and products.
- Simple form to fill out and submit for members to view what other DOT's have tried and listens learned Best Practices.
- Research new maintenance initiatives and potential research statements.
- Consistent maintenance activities throughout DOT's.
- Alignment on policies, procedures, and specifications (minimize duplication of effort and align best practices).
- Face-to-face meetings with each state in PFS.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: National Road Research Alliance (NRRRA)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(341)	MDOT START DATE	2/22/2016
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/30/2018
OR NO.	OR15-531	COMPLETION DATE (Revised)	2/22/2021
MDOT TECHNICAL CONTACT	Curtis Bleech, 517-322-5769 BleechC@michigan.gov		
LEAD AGENCY:	Minnesota DOT		
PROJECT MANAGER	Glenn Engstrom, 651-366-5531 glenn.engstrom@state.mn.us		
CONTRACTOR			

BUDGET STATUS					
FY 2019 Budget			Total Budget		
FY FUNDS	(Original)	\$0.00	TOTAL COST	(Original)	\$450,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$0.00	Total Committed Funds Available		\$0.00

PARTICIPATING STATES	
ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.	
CA , IL , MI , MN , MO , WI	

PURPOSE AND SCOPE

Primary objectives of the National Road Research Alliance (NRRRA) are:

- Conduct structured construction, field testing and evaluation using the MnROAD cold weather facility.
- Evaluate pavement materials, equipment and methods under real-world conditions.
- Establish industry standards and develop performance measure for improving pavement performance.
- Develop and/or revise specifications and recommendations.
- Studying and promoting innovative techniques and technologies that will save agencies money, improve safety and increase efficiency.
- Supporting technology transfer by developing practical field guides, best practices, and training curriculum to promote the results of research projects.
- Conduct cost-benefit analysis to ensure that new technologies, materials or methods contribute to operational efficiencies.
- Support the exchange of information and ideas through collaborative research efforts that provide opportunities for public agencies to share experiences.
- Identify and prioritize common road related research needs to address regional and national issues that are built on existing efforts such as FHWA's PCC and HMA Roadmaps as well as the Foundation for Pavement Preservation Roadmap.
- Fund high priority, readily implementable research projects through research contracts and university partnerships.
- Leverage knowledge, skills, and resources from participating partners to advance pavement research and implementation efforts while developing the workforce of the future.

Support technology transfer that highlights the implementation of research results and the associated benefits.

The scope of work for this pooled fund project is:

- Members provide the prioritized research needs, project development and design by way of the research project teams.
- Through the pooled fund members provide funding for high priority, readily implementable research projects.
- Participate in the planning of the reconstruction of MnROAD test sections in 2017 based on the established research needs developed; MnDOT will provide \$2.5 million of funding support to assist in the effort.
- Members receive timely results on NRRRA research projects through communication products that emphasize lessons learned and implementation.
- Assistance in putting research results into practice through technology transfer events.
- Membership in the Technology Transfer and Communication Teams.
- NRRRA members support committees that meet periodically throughout the year to determine priorities, develop strategies to address the priorities, and execute action plans.
- Sponsor students to work on specific prioritized research needs through academic contracts/grants.

FISCAL YEAR 2017 ACCOMPLISHMENTS

- Long Term Research Construction- finalized special provisions. MnDOT let the construction project (delayed) for 2017 construction at MnROAD. The long-term research construction effort is being funded with 2.5 million of MnDOT funds for NRRRA members to use.
- NRRRA Team Meetings were held monthly [w/ a few exceptions] and as needed to accomplish its tasks.
- Held the May 2017 NRRRA Pavement Conference and workshop on May 23-24, 2017.

- Significant Results - NRRRA Agencies and Associates members make up five (5) teams that play an important technical role in setting both the technology transfer and long-term research needs. Each team was active this summer meeting every two weeks to develop and prioritize ideas that fall into identified categories that meet local, state, regional and national research needs.
- Monitoring of various test cells. Continued material testing and analysis of the preliminary data collected to date.
- Completed construction of various test cells to be included in various studies. Actively continue development of long-term research needs in the various technical areas including RFP development. Promotion of the NRRRA seeking new members.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Continued monitoring and reporting on the various test cells. Continued Identification of Technology Transfer needs with webinars being offered on the many subjects. Continued PR outreach for additional members. Continued work and reporting out by the individual technical committees.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Continued PR outreach for new members including TRB booth and MnROAD's 25th Anniversary Open House. Phase II TPF-5(375) has been approved with research projects being solicited and scored for priority. Phase II extends this research venture an additional 5 years. In addition to new research projects PH II will also be used for additional monitoring and analyzation of PH I data from the low/high-volume pavement preservation sections built both in Alabama and Minnesota. With many of the test sections built in 2016, there was not ample time to identify the rates of deterioration that will be realized on the test sections. MnDOT is leading this portion of the pooled fund study and will again partner with NCAT for data collection in Alabama and most of the data analysis. Technical transfer efforts continue with presentation to various DOT's and organizations on current best practices and latest technologies. Continual efforts of data gathering, analyzation and reporting of findings from the various research aspects.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Continued PR outreach for new members and to inform everyone on the efforts and research efforts being conducted by the NRRRA. Research topic selection for PH II projects. TRB presence. Innovation solicitation for technical transfer topics. Construction of some of the PH II research project time and weather dependent. Provide additional webinars on a variety of subjects. Continual data collection analysis and research reports from the findings of the various research aspect.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Revised project completion date is February 22, 2021. MDOT has fulfilled its total pledge contribution amount of \$450,000.00 No programmed budget for FY's 2019-2021.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Continued evaluation of the findings of the various test sections and experimental designs and reporting out of the findings. Implementable results are in the form of recommendations from the reporting out of the findings, informational webinars, and Technology Transfer Sessions on a variety of subject matter.

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019

STUDY TITLE: Roadside Safety Research for Mash Implementation

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(343)	MDOT START DATE	10/1/2016
TPF- SOLICITATION NO.	1424	MDOT COMPLETION DATE (Original)	12/31/2018
OR NO.	OR15-528	COMPLETION DATE (Revised)	12/31/2021
MDOT TECHNICAL CONTACT	Carlos Torres, 517-355-2852 TorresC@michigan.gov		
LEAD AGENCY:	Washington DOT		
PROJECT MANAGER	Fheejay Painter, 360-705-7971 Paintef@wsdot.wa.gov		
CONTRACTOR			

BUDGET STATUS

FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$0.00	TOTAL BUDGET	(Original)	\$100,000.00
	(Revised)		TOTAL BUDGET	(Revised)*	\$200,000.00
TOTAL FY 2019 EXPENDITURES		\$0.00	TOTAL COMMITTED FUNDS AVAILABLE		\$100,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

AK , AL , CA , CO , CT , DE , FL , ID , IL , IA , LA , MD , MA , MI , MN , MO , MS , NY , OH , OK , ON , OR , PA , TN , TX , UT , WA , WI , WV

PURPOSE AND SCOPE

The objective of the Roadside Safety Pooled Fund Program is to provide a cooperative, cost-effective, and efficient approach to conducting research on roadside safety hardware meeting the functional needs of participating states. Emphasis will be placed on assisting State DOTs with their implementation of MASH, the transition to the use of MASH-compliant roadside safety devices in lieu of current NCHRP 350-compliant devices, as mandated in the revised FHWA-AASHTO Joint Implementation Plan and addressing other roadside safety needs of common interest.

Another objective of this pooled fund research is to provide each participating state an opportunity to send a representative to an annual meeting to collaborate with other state DOT safety engineers to assess best practices, new regulatory issues, risk management strategies, and other matters pertaining to roadside safety. Roadside Safety Pooled Fund members will meet, review potential projects for inclusion as part of future MASH crash testing projects, develop a work plan that involves selecting projects for future MASH crash testing, and designate individuals that will serve as team leaders for overseeing these projects.

Specific research activities expected to be addressed within the program include the design, analysis, testing, and evaluation of crashworthy structures, and the development of guidelines for the use, selection and placement of these structures. Crashworthy structures include bridge railings, guardrails, transitions, median barriers, cable barriers, temporary concrete barriers, end treatments, crash cushions (impact attenuators), culverts, breakaway support structures (e.g. sign supports, luminaire supports, mailboxes), and work zone traffic control devices. In addition, research is expected to address the influence of highway features such as driveways, slopes, ditches, shoulders, medians, and curbs on single vehicle collisions.

FISCAL YEAR 2016 ACCOMPLISHMENTS

Completed Projects

1. MASH Transition from F-Shape Temporary Concrete Barrier Pinned on Asphalt to Rigid Single-Slope Concrete Barrier
 - Test Report No. 605641-1; Test Report Date: January 2016
 - Benefit: Provides insight on methods to anchor temporary concrete barrier to permanent concrete barrier.
2. Guidebook for Use of Pinned-Down Temporary Concrete Barriers in Limited Space Applications
 - Test Report No. 605071-1; Test Report Date: April 2016
 - Benefit: Provides insight on an alternative limited deflection temporary concrete barrier system that meets MASH.
3. MASH Finite Element Analysis and Full-Scale Crash testing of Stacked W-Beam Transition for 31-inch Guardrail
 - Test Report No. 604581-1; Test Report Date: May 2016
 - Benefit: Provides information on a MASH-compliant guardrail anchorage that MDOT could use if desired.

Please note that MDOT joined the Roadside Pooled Fund in mid-2016, and the first Roadside Safety Pooled Fund meeting with MDOT participation is slated to take place in late October 2016. As a result, there was no input or involvement from MDOT in the three completed projects identified above.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Completed Projects

1. Barrier Deflection Characteristics of 31-inch W-Beam Guardrail Systems with 8-inch Blockouts.
 - Test Report No. 603481; Test Report Date: February 2017.
Benefit: Provides some insight on impact deflection characteristics for Type MGS-8 guardrail.
2. Guidance for Raising Beam Guardrail Composite Blockout for Rail Height Adjustment.
 - Test Report No. TM-605311; Test Report Date: February 15, 2017.
Benefit: Provides additional insight regarding guardrail height adjustments.

Pooled Fund Scorecard Development

The pooled fund, in conjunction with TTI, is in the process of developing scorecards for prioritizing MASH testing and evaluation of roadside safety devices. A scorecard (scorecard #1) was completed for guardrail and cast-in-place, permanent concrete barrier systems.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Pooled Fund Scorecards

The pooled fund, in conjunction with TTI, developed and completed a series of scorecards for prioritizing MASH testing and evaluation of roadside safety devices. The following scorecards were completed:

- #2: Guardrail terminals, cable barrier systems, and impact attenuators
- #3a: Transitions
- #3b: Portable barriers
- #3c: Other longitudinal barriers
- #3d: All other terminals
- #3e: Bridge railings

Completed Projects

1. Keyed-In, Segmented, Single Slope Reinforced Permanent Concrete Barrier
 - Objective: Perform a MASH, TL-4 (Test 4-12) crash test on a 120-foot long installation (consisting of three 40-foot segments with no connections between adjacent segments) of 42" tall, Texas DOT (TxDOT), reinforced single slope permanent concrete barrier keyed into 1" thick asphalt pavement.
 - Results: The barrier successfully passed MASH Test 4-12. MASH Tests 4-10 (small car) and 4-11 (pickup truck) were not performed due to successful past testing.
2. MASH Testing of Oregon DOT, F-Shape Temporary Concrete Barrier (TCB) Pinned to Concrete Pavement
 - Objectives: Determine a suitable offset between the TCB and the edge of the concrete pavement, and perform a MASH, TL-3 (Test 3-11) crash test on the pinned TCB with the selected offset from the edge of pavement. The F-shape TCB design used on this project was the Oregon DOT, F-shape TCB design.
 - Results: A 9-inch (minimum) offset was determined to be suitable for the design to meet MASH, TL-3 requirements when pinned to an 8-inch thick (minimum) concrete pavement. The barrier successfully passed MASH Test 3-11 with a 9-inch offset from the edge of pavement and pinned to an 8-inch thick concrete pavement.
3. 31-inch Tall Buried-in-Backslope (BIB) Terminal Compatible with MGS Guardrail
 - Objective: Develop a 31" tall buried-in-backslope that is compatible with MGS guardrail, MASH, TL-3 compliant, and suitable for installation on a V-ditch with a 1:4 or flatter foreslope, and a 1:2 or flatter backslope.
 - Results: The BIB terminal successfully passed MASH Tests 3-34 and 3-35.

A meeting was held in September 2018 in Denver, Colorado with the pooled fund member states and TTI to discuss ongoing projects and select and prioritize future projects.

FISCAL YEAR 2019 ACCOMPLISHMENTS

MASH Testing of W-beam Guardrail in Concrete Mow-Strip

- Objectives: Determine MASH, TL-3 compliance of Type MGS-8 guardrail, with wood and steel posts, installed in a concrete mow strip.
- Results: Both MASH, TL-3 tests (i.e., tests 3-10 and 3-11) involving the steel post version of Type MGS-8 guardrail passed. However, with the wood post version of Type MGS-8 guardrail, only test 3-10 (i.e., small car test) passed. Test 3-11 (i.e., pickup truck test) failed. A subsequent test (3-11) was performed using a shorter (36" long) wood post, and this test also resulted in a failure. Therefore, additional research is needed to determine if Type MGS-8 guardrail with wood posts can meet MASH, TL-3 criteria when placed in a concrete mow strip.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

1. Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States
2. MASH TL-3 T-Intersection (Short Radius) System Design Variations
3. Testing of MGS System with Reduced Post Spacing for MASH Compliance
4. MASH TL-3 Testing of Flared MGS System
5. Thrie-Beam/W-Beam/Tubular Barrier Gap Rail for MASH TL-3
6. MASH TL-3 Guardrail on 1:1 Slope
7. Accommodating Inlets with Transitions (TL-3)
8. Determination of Pedestrian Rail Offset Requirements to Eliminate Vehicle Interaction
9. MASH Coordination Effort
10. Testing and Evaluation of Large Sign Slipbase Support on Slope at MASH Test Level 3 Impact Conditions

-
11. MASH TL-4 Testing of Critical Flare Rate for Cast-in-Place (CIP) Concrete Barrier Flaring Around Fixed Object
 12. Review and Investigation of W-Beam Guardrail Terminals with Curbs

Approved Projects

1. Shorter TL-3 MASH W-Beam Transition
2. MASH TL-4 Testing and Evaluation of a Concrete Median Barrier with Fence Mounted on Top of Barrier
3. MASH TL-3 Testing of Guardrail on 6H:1V Slope
4. Accommodating Inlets with Transitions
5. Length of Need (LON) for Guardrail without Anchorage: Phase 1

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

In FY 2020 MDOT/FHWA approved a revised total project budget amount of \$200,000.00. The amount of federal funds available to transfer in FY 2020 is \$100,000.00.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Reports published by the Texas A&M University Transportation Institute (TTI) as part of the Roadside Safety Pooled Fund will be reviewed by MDOT's Barrier Advisory Committee (BAC). Reports will be reviewed individually by BAC, prioritized based on relevance of topics contained in each report based on MDOT's roadside safety needs.

BAC will then propose recommendations, as deemed appropriate, concerning the results and recommendations from these reports. BAC recommendations involving the development of new MDOT guidelines, standards, etc. or modifications to existing MDOT guidelines, standards, etc. may need to be submitted to others within MDOT (e.g., MDOT's Engineering Operations Committee (EOC)) for further consideration and approval before implementation. These decisions will be evaluated on a case-by-case basis.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Regional Roadside Turfgrass Performance Testing Program					
FUNDING SOURCE: <input checked="" type="checkbox"/> FHWA <input type="checkbox"/> OTHER (PLEASE EXPLAIN)					

TPF NO.	TPF-5(346)		MDOT START DATE	3/25/2016
PROJECT NO.	Old Solicitation 1412		MDOT COMPLETION DATE (Original)	9/30/2019
OR NO.	OR15-529		COMPLETION DATE (Revised)	9/30/2020
MDOT TECHNICAL CONTACT	Steve Urda (Interim through 12/31/2019.) UrdaS@michigan.gov			
LEAD AGENCY:	Minnesota DOT			
PROJECT MANAGER	Debra Flick, 651-366-3759 deb.flick@state.mn.us			
CONTRACTOR				

BUDGET STATUS					
FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$20,000.00		TOTAL BUDGET	(Original)
	(Revised)				(Revised)
TOTAL FY 2019 EXPENDITURES		\$20,000.00		TOTAL COMMITTED FUNDS AVAILABLE	\$20,000.00

PARTICIPATING STATES	
ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.	
MI, MN , NE , NJ , WI	

PURPOSE AND SCOPE	
<p>This multi-state research project aims to provide participating departments of transportation with unbiased, up-to-date information about the performance of turf grass cultivars when used on roadsides in the northern United States. This project has four objectives:</p> <ol style="list-style-type: none"> 1. Institute a multi-state roadside turf grass testing program. 2. Develop a data collection and reporting system that provides the most recent research results to state DOTs in a timely manner. 3. Increase collaboration between University research programs that work on roadside turf. 4. Demonstrate the usefulness of regional roadside turf grass research in order to increase collaboration between Departments of Transportation in future years. 	

FISCAL YEAR 2016 ACCOMPLISHMENTS	
<ol style="list-style-type: none"> 1. 2016 was the first year of participation for MDOT. Project work plan and university research team was established; Michigan State University will be MDOT's co-investigator. Performance testing parameters and Michigan roadside locations were selected to conduct two roadside trials of individual cultivars submitted by public and private breeders. 2. Increased collaboration between University research programs that work on roadside turf. Investigate and share current data on turf grass seed species and varieties best suited to survive in the roadside environment of northern states. 	

FISCAL YEAR 2017 ACCOMPLISHMENTS	
180 Seed test plots were planted in Q3 2017 on both urban and freeway roadsides.	

FISCAL YEAR 2018 ACCOMPLISHMENTS	
<ol style="list-style-type: none"> 1. 60 seed varieties will be evaluated for establishment rates, persistence, salt tolerance, vigor and health. 2. Turf grass species, varieties and BMP's will be evaluated and shared with participating states. 3. MSU evaluated grass species and developed a report on germination and roadside use and distributed to participating states. 4. MDOT added two varieties to Qualified Products as a result of this research project. 	

FISCAL YEAR 2019 ACCOMPLISHMENTS	
MDOT continues to monitor 60 grass varieties for salt tolerance, vigor, health and erosion control for future consideration of adding grass seed varieties to the Qualified Products List.	
TPF website not updated sufficiently to know FY 2020 plans.	

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))	
FY2020 SPR-II Program added \$20,000.00 in pledge contributions to the project, if needed. The MDOT Project Manager (PM) retired in Fall 2019 and an interim PM was assigned.	

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION	
The multi-state testing model is intended to provide recent, unbiased data upon which to make seed mixture recommendations.	

**RESEARCH ADMINISTRATION
TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Development of Maintenance Decision Support System

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(347)	MDOT START DATE	10/01/2012
PROJECT NO.		MDOT COMPLETION DATE (Original)	09/30/2021
OR NO.	OR14-034	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	James Roath, 517-230-5361 Roathj1@michigan.gov		
LEAD AGENCY:	South Dakota Department of Transportation		
PROJECT MANAGER	David Huft, 605-773-3358 Dave.huft@state.sd.us		
CONTRACTOR	Meridian Environmental Technology, Inc.		

BUDGET STATUS

FY 2019 Budget			Total Budget		
FY FUNDS	(Original)	\$25,000.00	TOTAL BUDGET	(Original)	\$75,000.00
	(Revised)		TOTAL BUDGET	(Revised)	\$125,000.00
TOTAL FY 2019 EXPENDITURES		\$25,000.00	Total Committed Funds Available		\$50,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

CA, CO, IA, ID, IN, KS, KY, MD, MI, MN, ND, NE, NH, NY, PA, SD, VA, WI, and WY

PURPOSE AND SCOPE

Develop a Maintenance Decision Support System (MDSS) winter maintenance operations forecasting tool (computer web-based) that helps reduce winter maintenance costs, increases level of service based on recommendations, and helps provide a reduction in damage to infrastructure and the environment. Pilot the MDSS winter maintenance forecasting tool in the Southwest Region during the 2012 & 2013 winter seasons. Implement the forecasting tool statewide during the 2014, 2015, 2016, and 2017 winter seasons.

FISCAL YEAR 2012 ACCOMPLISHMENTS

Meridian provided training in-person, via email, and over teleconference. The MDSS Graphical User Interface (GUI) manual was updated to reflect the new features that had been developed before the 2012 winter season. The development of a reference guide was also developed and distributed.

FISCAL YEAR 2013 ACCOMPLISHMENTS (Benefits to MDOT)

The following products or services were delivered from study activities performed in 2013:

- Refinement of GUI for quality forecasts.
- Refined interface/screen displays.
- Continued support for training in MDOT maintenance garages.
- MDSS smart phone application (app) for Android platform (Currently working on an iPhone app).

Deliverables that will benefit MDOT if implemented include:

- Refined forecast and treatment recommendation.
- Better system functionality of the GUI.
- More efficient use of the MDSS program by staff as a result of training.
- Forecast and treatment recommendations providing anticipated savings on materials used.
- Collaboration with other states on better use of the program and changes needed.

FISCAL YEAR 2014 ACCOMPLISHMENTS

- Continued refinement of GUI.
- Development of MDSS website.
- Refined interface/screen displays.
- Continued support for training in MDOT maintenance garages.
- Developed MDSS app for IOS.
- Refined forecast and treatment recommendations.
- Created dashboards.
- More efficient use of MDSS program by staff as a result of training.
- Forecast and treatment recommendations providing anticipated savings on materials used.
- Collaboration with other states on better use of program and changes needed.

FISCAL YEAR 2015 ACCOMPLISHMENTS

Iteris provided MDSS training to MDOT users across the state. They continued to refine the MDSS website by adding features and functions from the GUI that are useful to maintenance crews. Iteris continues to work on MDSS training videos and have completed 21 short videos for users. The intent is to provide short videos explaining a specific topic, so users have access to training information whenever they need it. Iteris also developed 'dashboards' to allow users to very quickly see current and forecasted weather data for user defined locations.

FISCAL YEAR 2016 ACCOMPLISHMENTS

Iteris has developed a new MDSS website (WebMDSS) that includes functionality like the MDSS GUI. The vendor and Technical Advisory Committee (TAC) identified and prioritized the most valuable functions from the GUI to be incorporated into the web-based application. The vendor has included all tier one prioritized items into the WebMDSS site and will continue to add functionality throughout 2017. The vendor has also successfully added weather, road, and maintenance reporting to the MDSS mobile application. This addition enables users to conveniently input data that can improve accuracy and recommendations.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Iteris has accomplished the following tasks during fiscal year 2017:

- Incorporated MDSS GUI functionality into WebMDSS.
- Refined and evaluated the capability and performance of MDSS software components, including surface condition prediction models and MDSS GUI.
- Recommend, developed, and evaluated methods for enhancing highway agencies' management through interfaces between MDSS and other management systems.
- Provided weather forecast support, MDSS configuration support, live MDSS operations, and necessary training for continuing limited deployment field trials.
- Prepared a final report summarizing methodology, findings in performance, conclusions and recommendations.
- Made an executive presentation to the project's Technical Panel and provide electronic copies of the presentation material to participating states.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Iteris has accomplished the following tasks during fiscal year 2018:

- Investigated ways to incorporate mobile road weather information system (RWIS) data into MDSS. Developed ways to display the data.
- Performed enhancements & adjustments to existing MDSS module.
- Continued efforts associated with Assessment of Recommendations (AoR) and reported out results to the project's Technical Panel.
- Designed & developed & released an updated mobile application for MDSS.
- Continued to fine tune the WebMDSS interface.
- Explored additional route configuration capabilities to MDSS that will enhance route recommendations.
- Improved understanding of traffic in MDSS.
- Prepared report summarizing research and made an executive presentation to the project's Technical Panel.

FISCAL YEAR 2019 ACCOMPLISHMENTS

- New Version of WebMDSS, improved Data Display, added overlay options to maps, favoriting capabilities and new lists views
- Ended the MDSS GUI and transitioned every user over to WebMDSS
- Provided trainings on the new MDSS App and WebMDSS
- Created a new Dashboard feature to improve the sites user ability
- Continue to perform enhancements and adjustments to existing MDSS modules (on-going task).
- Added additional routes to MDSS with the additional configurations. Received more feedback from users on additional configurations and materials

FISCAL YEAR 2020 PROPOSED ACTIVITIES

- Continued Enhancement of WebMDSS - After moving of the existing features from the MDSS GUI to WebMDSS there are several additional features/capabilities that could be developed and added to the WebMDSS interface. Some of these include simplifying certain aspects of the website creating a better user experience by customizing more display data features and providing ways for the table and graph views to be more interactive and user friendly.
- Modeling Integration of Mobile RWIS - WebMDSS can only display the data reported by Mobile RWIS. The next step is to integrate the reported data into the pavement model. This will allow Mobile RWIS data to affect the MDSS road conditions and maintenance recommendations. Certain considerations will also need to be made, for example, if both a Mobile RWIS and an MDC/AVL-equipped truck are reporting different conditions on the same route, which one takes precedence
- Improved In-vehicle MDSS Capabilities - In-vehicle MDSS, or VMDSS, is the interface used to provide MDSS capabilities (weather, road conditions, recommendations, etc.) inside the cabs of the trucks. VMDSS has remained relatively unchanged since it was developed. Thus, it could use some updating, or an overhaul. For one, Adobe Flash is being shut down within the next year which requires the VMDSS radar display to be replaced. Users have requested more feedback to the operators regarding how their maintenance is affecting MDSS recommendations
- MDSS Modeling Upgrades - There haven't been many substantial changes to MDSS' modeling engine during recent phases of work, but a growing list of desired enhancements has been accumulating. Potential areas of enhancement include improved logic for modeling chemical residuals atop roadways, investigation into how MDSS' ability to differentiate between prewet and liquid treatments might be improved, and the impact of exothermic chemical additives on the performance of the more basic endothermic deicers (such as salt).

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

MDOT's original total funding commitment was allocated over FY's 2012, 2013, and FY's 2015-2017. The lead agency requested all partner states to transfer future funds for existing TPF-5(054) to TPF-5(347); which is a new continuation study.

*TAC members assess future research needs on an annual basis. If new projects are identified and approved, they are incorporated on the annual work plan; which may extend the overall study an additional year. The new TPF-5(347) pooled fund study's duration must not exceed five years [FY's 2017- 2021]. As such, MDOT has posted its funding commitments through FY 2021 to the TPF website.

During FY 2017, TAC members identified several areas where the MDSS can be upgraded to provide additional value to transportation agencies. Thus, members approved the following additional tasks for FY 2018 and beyond.

Tasks include:

- Developing and refining the performance of the MDSS website (WebMDSS).
- Performing basic field research to improve MDSS forecasting accuracy.
- Developing a module to include real-time traffic data into MDSS.
- Improving the MDSS smart phone applications.
- Designing and developing a dashboard like interface within the MDSS GUI.
- Advanced Management Reporting Tools.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Due to the success of the implementation in the Southwest Region, the department has expanded its use of MDSS to include all garages statewide. MDOT has recently selected a vendor to provide AVL/GPS as well as a fully functional MDSS for all maintenance garages. The MDSS will include snow route specific treatment recommendations as well as a detailed garage specific weather forecast. As of October 1, 2015, we have started implementing MDSS into our contract agency operations and will continue to roll-out MDSS to contract agencies through Fiscal Year (FY) 2018. All contract counties will have access to the MDSS website and will receive training from MDOT staff.

The success of the pooled fund study is a direct result of strong collaboration between the participating states and the contractor. MDSS continues to grow and evolve, new interfaces and functionality are being added that will increase the benefits of the system. Continued participation in this pooled fund will enable MDOT to have:

- Winter weather information from a single, user friendly source (website & mobile application).
- Improved anticipation of storm events and road conditions.
- More consistent winter maintenance by all maintenance units.
- Reduced environmental exposure to deicing chemicals.
- Powerful reporting and analytical tools for managers.

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019

STUDY TITLE: Self De-Icing LED Signals			
FUNDING SOURCE: <input checked="" type="checkbox"/> FHWA <input type="checkbox"/> OTHER (PLEASE EXPLAIN)			
TPF NO.	TPF-5(351)	MDOT START DATE	3/25/2016
PROJECT NO.		MDOT COMPLETION DATE (Original)	8/14/2019
OR NO.	OR15-530	COMPLETION DATE (Revised)	6/30/2021
MDOT TECHNICAL CONTACT	Erik Smalley, 517-636-6108 SmalleyE@michigan.gov		
LEAD AGENCY:	Kansas DOT		
PROJECT MANAGER	Susan Baker, 785-291-3847 susan.barker@ks.gov		
CONTRACTOR			

BUDGET STATUS					
FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$0.00	TOTAL BUDGET	(Original)	\$60,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$0.00	TOTAL COMMITTED FUNDS AVAILABLE		\$0.00

PARTICIPATING STATES
ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.
CA, KS, WI, MI, PA, NJ

PURPOSE AND SCOPE
This proposed research project will develop and test different types of prototype self-deicing LED signals over a project period of three years. Project objectives are to develop multiple prototypes of a new type of self-deicing LED signals for highway signalized intersections and railroad signaling applications and validate them using field tests.

FISCAL YEAR 2016 ACCOMPLISHMENTS (Benefits to MDOT)
The TAC members approved the project scope. Devices were constructed for use during the 2016/2017 winter. Deliverables that might benefit MDOT if implemented include LED lens devices that will de-ice automatically when necessary and improve safety.

FISCAL YEAR 2017 ACCOMPLISHMENTS

Developed 3 prototype signals. Began testing.

As of September 30, 2017, we have achieved the following significant results.

- This project was launched in Aug 2016 with six participating states (Kansas, California, Michigan, New Jersey, Wisconsin and Pennsylvania) and an initial budget of \$240,000. Maryland is expected to officially join the study by the end of this year with additional contribution of three years funding.
- An expert panel meeting was held in early March. Discussions were held on desired specifications of the prototype signals and possible field tests sites as well as the field evaluation of the prototypes.
- Necessary equipment, components and insulation materials are being procured to develop and build the fully working prototypes of the finalized design and test for their thermal and lighting performance. We will continue to order LED drivers, electricity monitors, waterproof security video cameras, other mounting accessories and materials, etc. for monitoring the performance of the prototypes in the field tests in the upcoming winter season.
- Appropriate color LED modules, which are not available in the market, were designed in-house and custom-made with the aid of the industrial partner.
- Three preliminary prototype signals (Red, Yellow, and Green) of Type 1 have been developed in-house, each deploying 26 custom-made colors LEDs mounted in an array vis "Heat Arrangement of LED Arrays in Low Profile". They are under laboratory testing for improvements.
- Tested the lighting and thermal performance of the preliminary prototypes of the Type 1 signal lights. Based on the result, new design with a lot of changes and improvements has been finalized for final products.

- Finalized the design of Type 1 self de-icing LED signals using 96 custom-made mediate-power color LED mounted in an array via "Heat Arrangement of LED Arrays in Low Profile". Designed in- house and custom-made our own color LED modules (for each color R, G, Y) for making the fully working prototype signals for the first type with the aid of our industrial partner.
- Worked with the factories to optimize the mounting method of the custom-made LED modules on the 3-5 mm thick aluminum MPCB back plate serving as the passive heat exchange if aluminum alloy for assembly.
- Custom-made three prototypes of the LED signals of Type 1 using 96 custom-made mediate-power color LEDs mounted in an array via "Heat Arrangement of LED Arrays in Low Profile", with regular paint coating, and finished laboratory for improvements and optimizations to finalize the design.
- Improved and custom-made three new signal light engines using 96 custom-made mediate-power color LEDs mounted in an array via "Heat Arrangement of LED Arrays in Low Profile" but with TIN coating and tested them to improve the heating performance (to make faster heat transfer).
- Finalized the design of the signal lens that adopts a whole piece design with smooth and flat outside surface and integrated with 96 additional custom-made Fresnel lenses sitting inside the signal lens over each MED on the inside surface to focus the light serving as a collimator lens. Based on the testing results, the signal light engines with TIN coating may have superior thermal performance, however, further testing in the laboratory and filed is necessary to validate the final choice.
- Identified and started custom-making the Fresnel Lens from HongXuan Optoelectronic with diameter 15 mm and focal length 6 mm.
- Developed the new whole-piece signal housing, new Fresnel lenses, LED drivers, and other accessories for the Type 1 self de-icing LED signal lights, with the aid of the industrial partner.
- Found and selected a qualified plastic molding company to custom make the three parts of the plastic housing of fully working prototypes of Type 1 signals that deploy 96 mediate-power LEDs vis the architecture of "Heat Arrangement of LED Arrays in Low Profile". The new housing will be used for the new LED signal lights.
- Started custom-making and modeling of the signal housing, which takes time to complete.
- Started custom-making the LED drivers with desired specifications based on our test results.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Develop and make whole piece housings, test prototypes in closed settings; stage 2 to begin. As of September 30, 2018, we have achieved the following significant results.

This project was launched in Aug 2016 with six participating states (Kansas, California, Michigan, New Jersey, Wisconsin, and Pennsylvania) and an initial budget of \$240,000. Maryland is expected to officially join the study by the end of this year with additional contribution of three years funding.

An expert panel meeting was held in early March. Discussions were held on desired specifications of the prototype signals and possible field test sites as well as the field evaluation of the prototypes.

Necessary equipment, components and insulation materials are being procured to develop and build the fully working prototypes of the finalized design and test for their thermal and lighting performance. We will continue to order LED drivers, electricity monitors, waterproof security video cameras, other mounting accessories and materials, etc., for monitoring the performance of the prototypes in the field tests in the upcoming winter season.

Appropriate color LED modules, which are not available in the market, were designed in-house and custom-made with the aid of the industrial partner.

Three preliminary prototype signals (Red, Yellow, and Green) of Type 1 have been developed in house, each deploying 26 custom-made color LEDs mounted in an array via "Heat Arrangement of LED Arrays in Low Profile". They are under laboratory testing for improvements.

Tested the lighting and thermal performance of the preliminary prototypes of the Type 1 signal lights (Figure 1). Based on the test results, new design with a lot of changes and improvements has been finalized for final products.

Finalized the design of Type 1 self de-icing LED signals using 96 custom-made mediate-power color LEDs mounted in an array via "Heat Arrangement of LED Arrays in Low Profile". Designed in house and custom-made our own color LED modules (for each color R, G, Y) for making the fully working prototype signals of the first type with the aid of our industrial partner.

Worked with the factories to optimize the mounting method of the custom-made LED modules on the 3-5 mm thick aluminum MPCB back plate serving as the passive heat exchangers of aluminum alloy for assembly.

Custom-made three prototypes of the LED signals of Type 1 using 96 custom-made mediate-power color LEDs mounted in an array via "Heat Arrangement of LED Arrays in Low Profile", with regular paint coating, and finished laboratory testing for improvements and optimizations to finalize the design.

Improved and custom-made three new signal light engines using 96 medium-power LEDs (0.25 Watt each) mounted in an array via "Heat Arrangement of LED Arrays in Low Profile" but with Tin coating (Figure 3) and tested them to improve the heating performance (to make faster heat transfer).

Finalized the design of the signal lens that adopts a whole piece design with smooth and flat outside surface and integrated with 96 additional custom-made Fresnel lenses sitting inside the signal lens over each LED on the inside surface to focus the light serving as a collimator lens. Based on the testing results, the signal light engines with TIN coating may have superior thermal performance, however, further testing in the laboratory and field is necessary to validate the final choice.

Identified and started custom-making the Fresnel Lens from HongXuan Optoelectronic company with diameter 15 mm and focal length 6 mm (model # HX-F015006).

Developed the new whole-piece signal housing, new Fresnel lenses, LED drivers, and other accessories for the Type 1 self de-icing LED signal lights, with the aid of the industrial partner.

Found and selected a qualified plastic molding company to custom make the three parts of the plastic housing of fully working prototypes of Type 1 signals that deploy 96 mediate-power LEDs via the architecture of "Heat Arrangement of LED Arrays in Low Profile". The new housing will be used for the new LED signal lights.

The non-provisional patent application for the invention of Type 2 self de-icing signal light was officially approved by the USPTO and issued on Dec 26, 2017, patent No. US 9,851,086 B2.

Started custom-making and modeling of the signal housing. Three samples were delivered for examinations and laboratory tests for necessary calibrations and further improvements.

Started custom-making the LED drivers with desired specifications based on our test results. Seven LED drivers were delivered for sample testing.

The custom-made signal housing is ready for production of products with possible minor adjustments for field tests in different states. Six improved samples have been delivered and thoroughly tested in laboratory and closed-setting tests on the roof.

New type of screws for uses in the signal housing are self-designed and will be custom-made with Fastenal company.

A company is custom making two improved and finalized types of LED driver, one for YELLOW and GREEN signal lights (output 0.8 A, maximum 30 Watts), the other for RED signal light (output 1.1 A, maximum 30 Watts). The new LED drivers have temperature Sensor control, when the temperature is above 4 degree Celsius, the LED driver output will be derated (For Yellow + Green LED lights, output current 0.5 A, approximately 17- 18 Watts; For Red LED light, output current min 0.6 A, approximately 15-16 Watts.) When the temperature sensor is turned off or failed for any reasons, the power output will be restored to 100% as default.

The self-deicing signal lights have higher light output than the codes and standards required in all viewing angles from 0 deg to 70 deg as measured, even at the derated power output.

We have been conducting a closed-course performance and reliability tests of the fully working prototypes mounted on the roof of the University of Kansas engineering complex - M2SEC building, in preparation for field tests.

Seven states have officially participated in this project, including Kansas, California, Michigan, New Jersey, Wisconsin, Pennsylvania and Maryland to provide support.

A project addendum is proposed to conduct two additional field tests, one in Wisconsin and another one in a test site among Maryland, Pennsylvania, and New Jersey. A budget of \$80,000 for the addendum is proposed to be spent starting on 5/18/2018 until the end of the project.

We have been continuously testing the closed-course performance and reliability of the prototypes previously mounted on the roof of M2SEC building (Figure 1). All signal lights were powered by the signal controller cabinet with real signaling time cycles (in a cycle

length of 90 seconds, Red signal light ON for 50 seconds, Green signal light ON for 35 seconds, and Yellow signal light ON for five seconds. The temperature data were recorded every 10 seconds continuously over the entire test period, which will be continuously conducted over both winter and summer seasons in 2019.

We have designed and custom made new types of screws (Figure 3, the bottom pictures) to improve the connection strength of the screws integrated with the plastic housing. This type of screws are finalized products to be used in all finalized plastic housing.

We have designed and custom made two types of LED drivers, as shown in Figure 4, including one type of custom-made LED driver for red signal light (input: 100-240 VAC, output: 0.6-1.1 A, max 30 W), and a second type custom made LED driver for green/yellow signal light (input: 100-240 VAC, output: 0.5-0.8 A, max 30 W). Both types of LED drivers are now integrated with a remote temperature sensor (see Figure 4) for controlling the power output in light of the ambient air temperature. An on/off switch is designed for temperature controls in winter and summer modes which could override the operation of the temperature sensor.

We have accordingly improved and finalized the plastic housing of the fully working prototype signals of Type 1 with changes/improvements listed below, with assist of the plastic molding company Eco Molding. Eco Molding company has custom made seven samples (Figure 5) of the finalized new plastic housing for validations tests before actual product production.

We have produced 60 pcs of the finalized LED engines with the aid of the industrial partner (Figure 6a), ready for the upcoming field tests.

We have also updated and custom made 60 pcs of glass disc (Figure 6b) which have four small mounting holes removed on the edge (the original glass disc had 8 mounting holes).

We also custom made plastic mounting bars (Figure 6b) for mounting the glass disc to the LED light engine.

We are working on getting improvement on custom-made Fresnal lens model number HX-F0150115 (diameter 15 mm, thickness 2.0 mm, focal length 11.5 mm) to increase tolerance of the thickness (approximately 1.8 – 2.1 mm) while reducing the unit cost.

FISCAL YEAR 2019 ACCOMPLISHMENTS

As of June 30, 2019, we have achieved the following significant results.

This project was launched in Aug 2016 with six participating states (Kansas, California, Michigan, New Jersey, Wisconsin, and Pennsylvania) and an initial budget of \$240,000. Maryland is expected to officially join the study by the end of this year with additional contribution of three years funding.

An expert panel meeting was held in early March. Discussions were held on desired specifications of the prototype signals and possible field test sites as well as the field evaluation of the prototypes. Necessary equipment, components and insulation materials are being procured to develop and build the fully working prototypes of the finalized design and test for their thermal and lighting performance. We will continue to order LED drivers, electricity monitors, waterproof security video cameras, other mounting accessories and materials, etc., for monitoring the performance of the prototypes in the field tests in the upcoming winter season.

Appropriate color LED modules, which are not available in the market, were designed in-house and custom-made with the aid of the industrial partner.

Three preliminary prototype signals (Red, Yellow, and Green) of Type 1 have been developed in house, each deploying 26 custom-made color LEDs mounted in an array via "Heat Arrangement of LED Arrays in Low Profile". They are under laboratory testing for improvements.

Tested the lighting and thermal performance of the preliminary prototypes of the Type 1 signal lights (Figure 1). Based on the test results, new design with a lot of changes and improvements has been finalized for final products.

Finalized the design of Type 1 self de-icing LED signals using 96 custom-made mediate-power color LEDs mounted in an array via "Heat Arrangement of LED Arrays in Low Profile". Designed in house and custom-made our own color LED modules (for each color R, G, Y) for making the fully working prototype signals of the first type with the aid of our industrial partner.

Worked with the factories to optimize the mounting method of the custom-made LED modules on the 3-5 mm thick aluminum MPCB back plate serving as the passive heat exchangers of aluminum alloy for assembly.

Custom-made three prototypes of the LED signals of Type 1 using 96 custom-made mediate-power color LEDs mounted in an array via "Heat Arrangement of LED Arrays in Low Profile", with regular paint coating, and finished laboratory testing for improvements and optimizations to finalize the design.

Improved and custom-made three new signal light engines using 96 medium-power LEDs (0.25 Watt each) mounted in an array via "Heat Arrangement of LED Arrays in Low Profile" but with Tin coating (Figure 3) and tested them to improve the heating performance (to make faster heat transfer).

Finalized the design of the signal lens that adopts a whole piece design with smooth and flat outside surface and integrated with 96 additional custom-made Fresnel lenses sitting inside the signal lens over each LED on the inside surface to focus the light serving as a collimator lens. Based on the testing results, the signal light engines with TIN coating may have superior thermal performance, however, further testing in the laboratory and field is necessary to validate the final choice.

Identified and started custom-making the Fresnel Lens from HongXuan Optoelectronic company with diameter 15 mm and focal length 6 mm (model # HX-F015006).

Developed the new whole-piece signal housing, new Fresnel lenses, LED drivers, and other accessories for the Type 1 self-de-icing LED signal lights, with the aid of the industrial partner.

Found and selected a qualified plastic molding company to custom make the three parts of the plastic housing of fully working prototypes of Type 1 signals that deploy 96 mediate-power LEDs via the architecture of "Heat Arrangement of LED Arrays in Low Profile". The new housing will be used for the new LED signal lights.

The non-provisional patent application for the invention of Type 2 self de-icing signal light was officially approved by the USPTO and issued on Dec 26, 2017, patent No. US 9,851,086 B2.

Started custom-making and modeling of the signal housing. Three samples were delivered for examinations and laboratory tests for necessary calibrations and further improvements.

Started custom-making the LED drivers with desired specifications based on our test results. Seven LED drivers were delivered for sample testing.

The custom-made signal housing is ready for production of products with possible minor adjustments for field tests in different states. Six improved samples have been delivered and thoroughly tested in laboratory and closed-setting tests on the roof.

New type of screws for uses in the signal housing are self-designed and will be custom-made with Fastenal company.

A company is custom making two improved and finalized types of LED driver, one for YELLOW and GREEN signal lights (output 0.8 A, maximum 30 Watts), the other for RED signal light (output 1.1 A, maximum 30 Watts). The new LED drivers have temperature Sensor control, when the temperature is above 4 degree Celsius, the LED driver output will be derated (For Yellow + Green LED lights, output current 0.5 A, approximately 17- 18 Watts; For Red LED light, output current min 0.6 A, approximately 15-16 Watts.) When the temperature sensor is turned off or failed for any reasons, the power output will be restored to 100% as default.

The self-deicing signal lights have higher light output than the codes and standards required in all viewing angles from 0 deg to 70 deg as measured, even at the derated power output.

We have been conducting a closed-course performance and reliability tests of the fully working prototypes mounted on the roof of the University of Kansas engineering complex - M2SEC building, in preparation for field tests.

Seven states have officially participated in this project, including Kansas, California, Michigan, New Jersey, Wisconsin, Pennsylvania and Maryland to provide support.

A project addendum is proposed to conduct two additional field tests, one in Wisconsin and another one in a test site among Maryland, Pennsylvania, and New Jersey. A budget of \$80,000 for the addendum is proposed to be spent starting on 5/18/2018 until the end of the project.

We have been continuously testing the closed-course performance and reliability of the prototypes previously mounted on the roof of M2SEC building. All signal lights were powered by the signal controller cabinet with real signaling time cycles (in a cycle length of 90 seconds, Red signal light ON for 50 seconds, Green signal light ON for 35 seconds, and Yellow signal light ON for 5 seconds. The temperature data were recorded every 10 seconds continuously over the entire test period, which will be continuously conducted over both winter and summer seasons in 2019.

We have designed and custom made new types of screws to improve the connection strength of the screws integrated with the plastic housing. This type of screws are finalized products to be used in all finalized plastic housing.

We have designed and custom made two types of LED drivers, including one type of custom-made LED driver for red signal light (input: 100-240 VAC, output: 0.6-1.1 A, max 30 W), and a second type custom made LED driver for green/yellow signal light (input: 100-240 VAC, output: 0.5-0.8 A, max 30 W). Both types of LED drivers are now integrated with a remote temperature sensor for controlling the power output in light of the ambient air temperature. An on/off switch is designed for temperature controls in winter and summer modes which could override the operation of the temperature sensor.

We have accordingly improved and finalized the plastic housing of the fully working prototype signals of Type 1 with changes/improvements listed below, with assist of the plastic molding company Eco Molding. Eco Molding company has custom made seven samples of the finalized new plastic housing for validations tests before actual product production.

We have produced 60 pcs of the finalized LED engines with the aid of the industrial partner, ready for the upcoming field tests.

We have also updated and custom made 60 pcs of glass disc which have four small mounting holes removed on the edge (the original glass disc had 8 mounting holes).

We also custom made plastic mounting bars for mounting the glass disc to the LED light engine.

We are working on getting improvement on custom-made Fresnel lens model number HX-F0150115 (diameter 15 mm, thickness 2.0 mm, focal length 11.5 mm) to increase tolerance of the thickness (approximately 1.8 – 2.1 mm) while reducing the unit cost.

We are in preparation for field tests. Three fully functional prototypes of the fourth generation were mounted on a signal pole on the roof of an engineering building, powered by a traffic control cabinet for closed-course performance and reliability tests.

Three more fully functional prototypes of the fourth generation were also tested in a well-controlled cold room for the performance of the ambient temperature sensor connected to the LED driver for switching full/derated power output. Based on the test results, we are adjusting the power output of the LED drivers. We are also making minor adjustments of the signal housing for quick assembly of the real products. Results have been used to evaluate the readiness of the prototypes for field tests starting in next quarter.

Corrected some problems and resolved issues of the custom-made LED drivers, including (1) decreased the size of the power connector of the temperature sensor, (2) decreased the length to 6 mm, (3) changed to more reliable single switch, (4) enlarged the inside size of the installation hole to 6mm x 4.5 mm, (5) changed the final designed output current of Yellow/Green LED drivers to 0.40 A (derated) /0.84 A(full output), (6) changed the final designed output current of Red LED drivers to 0.60 A (derated) /1.1 A(full output), (7) improvements on temperature measurement accuracy, redesigned logic circuits, and changes of electronic parts used on the LED PCB boards.

The signal housing of the fourth generation LED signal lights was revised for quick assembly. We have received the new prototypes of the housing with desired changes, which were tested in the laboratory with satisfactory performance.

Other parts like glass mounting discs have also been improved in house for enlarging the installation holes to fit the new housing.

Additional vendors for Fresnel lenses were contacted for lower unit price with higher quality control than the current lens vendor. Based on the lab test results, a total of 5000 PCS of new Fresnel lenses (Model #1511) were ordered from the new vendor for field tests.

Based on the lab test results on the second generation of LED drivers, a total of 21 pcs of the third generation of LED drivers were ordered for lab tests, in preparation for the field tests.

Monitoring cameras – Raspberry 3 B+ motherboard and accessories – have been designed and are currently being custom built in house, which will be mounted at each field test site for year-around real-time monitoring and data recording of the new signals to be tested in the field.

A new proposal was approved on extended work with increased total project cost of \$360K and extended new end date of June 30, 2021.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

1. Test and validate the improved third generation LED drivers, in qty of 21, to be used for final field tests.
2. Identify field test sites and test specifications at each site with the aid of sponsor states.
3. Assemble all improved prototypes to be tested in the field sites.
4. Travel to the field for field installation and field test.
5. Continue roof testing of the improved prototypes in the closed-setting for continuous improvements.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

Solicitation 1403 was assigned federal project number TPF-5(351)

The original project total budget of \$240,000.00 was increased to \$360,000.00

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2021.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Clear Roads Winter Highway Operations Pooled Fund

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(353)	MDOT START DATE	10/1/2016
PROJECT NO.		MDOT COMPLETION DATE (Original)	12/30/2021
OR NO.	OR13-015	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Melissa Longworth, 517-636-4386 LongworthM@michigan.gov		
LEAD AGENCY:	Minnesota Department of Transportation		
PROJECT MANAGER	Debra Fick, 651-366-3759 deb.fick@dot.state.mn.us		
CONTRACTOR			

BUDGET STATUS

FY 2019 Budget			Total Budget		
FY FUNDS	(Original)	\$25,000.00	TOTAL BUDGET	(Original)	\$125,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$25,000.00	Total Committed Funds Available		\$50,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.
AK AZ CA CO CT DE IA ID IL IN KS MA MD ME MI MN MO MT NE ND NH NY OH OR PA RI SD TX UT VA VT WA WI WV WY

PURPOSE AND SCOPE

This pooled fund project will maintain its focus on advancing winter highway operations nationally, but it will include a more pronounced emphasis on state agency needs, technology transfer, and implementation. State departments of transportation are aggressively pursuing new technologies, practices, tools, and programs to improve winter highway operations and safety while maintaining fiscal responsibility. This pooled fund is needed to evaluate these new tools and practices in both lab and field settings, to develop industry standards and performance measures, to provide technology transfer and cost benefit analysis, and to support winter highway safety. This project responds to research and technology transfer needs not currently met by other pooled fund projects. Existing partners make every effort to coordinate with other agencies to avoid duplication of efforts and to encourage implementation of results.

Objectives of this ongoing pooled fund project will include:

- Conducting structured field testing and evaluation across a range of winter conditions and different highway maintenance organizational structures to assess the practical effectiveness, ease of use, optimum application rates, barriers to use, durability, safety, environmental impact and cost-effectiveness of innovative materials, equipment, and methods for improved winter highway maintenance.
- Establishing industry standards and developing performance measures for evaluating and utilizing new materials and technologies.
- Supporting technology transfer by developing practical field guides and a training curriculum that will promote the results of research projects.
- Conducting cost-benefit analysis to ensure that new technologies, materials, or methods contribute to operational efficiency.
- Supporting the exchange of information and ideas via peer exchanges and collaborative research efforts that provide opportunities for maintenance specialists to share experiences related to winter maintenance.
- Promoting public education and outreach related to winter maintenance and winter driving safety.
- Conducting state of the practice surveys to share best practices on current operational issues. (For example: Salt shortages, level of service requirements, or other hot button issues).

Included in the Scope of work: Research reports, technical briefs, synthesis reports, field guides, specifications, PowerPoint presentations, video documentation, training materials, public safety messages, and software programs.

FISCAL YEAR 2012 ACCOMPLISHMENTS

Clear Roads closed out the following projects in Fiscal Year (FY) 2012:

- Mapping Weather Severity Zones.
- Snow Removal at Extreme Temperatures.
- Developing a Training Video for Field Testing of Deicing Materials.

The following research projects either began or remained in progress during FY 2012:

- Environmental Factors Causing Fatigue in Snowplow Operators.
- Cost-Benefit Analysis Toolkit - Phase II.
- Determining the Toxicity of Deicing Materials.
- Development of a Totally Automated Spreading System.
- Understanding the True Costs of Snow and Ice Control Operations.

MDOT staff will be incorporating results from some of these research projects into presentations given to our maintenance personnel at the Transportation Service Centers and contract agencies during Winter Operations Workshops in the fall.

FISCAL YEAR 2013 ACCOMPLISHMENTS (Benefits to MDOT)

The Clear Roads pooled fund study completed two research projects and several other projects commenced during the 2013 FY. The two completed projects and their respective deliverables are described below.

Cost-Benefit Analysis Toolkit - Phase II

An updated version of the cost-benefit analysis toolkit with enhanced features and expanded functionality to include additional materials, equipment, and methods was developed.

Snow Removal at Extreme Temperatures

The final report compiled strategies for winter maintenance during extreme cold events where salt is not an effective deicer. The strategies outlined in the report are currently used in other states and countries for maintaining an acceptable level of service during cold weather.

Deliverables that will benefit MDOT if implemented:

Cost-Benefit Analysis Toolkit - Phase II

MDOT has already used the toolkit to help justify instrumenting our winter maintenance truck fleet with AVL/GPS devices for monitoring the activities of our fleet, reporting the hours and miles driven, and operational data such as the amount of deicing material used, number of hours the plow blade was down, etc. By inputting MDOT specific cost data in the cost-benefit toolkit, we were able to generate a cost-benefit (C/B) that is specific to MDOT. This C/B information was provided to management.

Snow Removal at Extreme Temperatures

Some of the strategies as outlined in the final report were incorporated into our winter maintenance training program for use by our direct-force garages and contract agencies.

FISCAL YEAR 2014 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed two research projects and several other projects commenced during the 2014 FY. The two completed projects and their respective deliverables are described below.

Comparison of Materials Distribution Systems

This is a photographic catalog of all the different types of material distribution systems identified across the country. MDOT can use this catalog to see what others across the country are using for winter material application systems and examine them for potential use in Michigan.

Environmental Factors Causing Fatigue in Snowplow Operators

This project includes recommendations on some cost-effective solutions to mitigate driver fatigue and potential avenues for further research. The vendor for this project will be speaking on the subject at the 2015 LTAP winter conference. Methods to reduce fatigue is something that is important to MDOT.

FISCAL YEAR 2015 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed two research projects and several other projects commenced during the 2015 FY. The two completed projects and their respective deliverables are described below.

Best Practices for the Prevention of Corrosion to DOT Equipment: A User's Manual.

This is a guide that summarizes, in layman's terms, the best practices to prevent corrosion to maintenance equipment. The MDOT Fleet team is highly interested in the information presented in the corrosion guide and plans to incorporate it into best practice procedures for winter equipment.

Weather Severity Mapping Enhancement

This includes a set of state-specific maps tailored to each member state's interest. MDOT's Office of Field Services has used the Michigan Winter Severity Map to show management how winter weather can impact operating costs in different parts of the state. The map was also used to convey a new winter severity measuring process that MDOT adopted.

FISCAL YEAR 2016 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed five research projects and several other projects commenced during the 2016 FY.

- [14-01: Synthesis on GPS/AVL Equipment Used for Winter Maintenance](#) (September 2016)
- [13-02: Understanding the Effectiveness of Non-Chloride Liquid Agricultural By-Products and Solid Complex Chloride/Mineral Products Used in Snow and Ice Control Operations](#) (May 2016)
- [14-10: Roadway Salt Best Management Practices](#) (November 2015)
- [14-06: Use of Equipment Lighting During Snowplow Operations](#) (September 2015)
- [13-03: Cost-Benefit of Various Winter Maintenance Strategies](#) (September 2015)

Two of the five completed projects and their respective deliverables are described below.

2- 2016 Completed Projects/Respective Deliverables:

14-01: Synthesis on GPS/AVL Equipment Used for Winter Maintenance.

This project provided a current survey of GPS/AVL equipment and available functions. MDOT can use the information within this report to help plan for the new AVL/GPS contract needed within the coming year.

14-06: Use of Equipment Lighting During Snowplow Operations.

This project provided a current practice of plow truck equipment lighting across the country. It also provides recommendations and sample specifications. The Michigan legislature recently authorized the use of green lights for winter maintenance vehicles. This report could be used to help MDOT develop specifications for green lighting.

Five new projects were also authorized for solicitation.

FISCAL YEAR 2017 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed five research projects and several other projects commenced during the 2017 FY.

- 12-04 Snowplow Operator and Supervisor Training.
- 14-04 Plug and Play, Phase 2.
- 14-05 Snow Removal Performance Metrics – Phase I: Synthesis.
- 14-07 Snowplow Route Optimization.
- 15-03 North American Study on Contracting Snow and Ice Response.

Two of the five completed projects and their respective deliverables are described below.

2- 2017 Completed Projects/Respective Deliverables:

12-04 Snowplow Operator and Supervisor Training

The key outcomes of the project are presentations, course guides, exams and other training support materials for winter maintenance operations. MDOT can use the information to help train staff during winter operations schools, region trainings, and other training events.

14-04 Plug and Play, Phase 2

Clear Roads has been leading a collaborative effort called the Plug-and-Play Initiative to develop a universal bi-directional communications protocol for in-cab electronics, regardless of the manufacturer or service provider. This project identified the most appropriate standard protocols and made recommendations regarding the method of transmission. MDOT will use this research to assist with the development of an RFP for our automated vehicle location and maintenance decision support system.

Five new research projects and five new synthesis projects were also authorized for solicitation.

FISCAL YEAR 2018 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed five research projects, two synthesis projects and several other projects commenced during the 2018 FY.

- [14-02: Quantifying the Impact That New Capital Projects Will Have on Roadway Snow and Ice Control Operations \(November 2017\)](#)
- [15-02: Identification and Recommendations for Correction of Equipment Factors Causing Fatigue in Snowplow Operators \(November 2017\)](#)
- [12-03: Understanding the Chemical and Mechanical Performance of Snow and Ice Control Agents on Porous or Permeable Pavements\(January 2018\)](#)
- [16-04: Emergency Operations Methodology for Extreme Winter Storm Events \(May 2018\)](#)
- [16-06: Training Video for the Implementation of Liquid-Only Plow Routes \(June 2018\)](#)
- [16-S3: Maintenance Vehicle Conspicuity \(February 2018\)](#)
- [17-S1: Accuracy of Deicer and Abrasive Material Application Equipment \(September 2018\)](#)

Two of the five completed projects and their respective deliverables are described below.

12-03 Understanding the Chemical and Mechanical Performance of S&I Control Agents on Porous or Permeable Pavements

This project provided better information and guidelines to help determine the optimum maintenance strategies for porous or permeable asphalt pavements, including:

- Dense graded pavements.
- Open graded pavements.
- Ultrathin Friction Course.

14-02 Quantifying the Impact that New Capital Projects Will Have on Roadway Snow and Ice Control (RSIC) Operations

The project developed an automated method of quantifying the anticipated impact that new capital projects will have on costs for RSIC. This method could be used in the early stages of project development to determine if an agency will need additional resources, such as trucks, salt, fuel, and manpower, to accomplish winter maintenance tasks after the project is completed. This methodology could also be used by maintenance managers to justify requests for additional resources after projects are complete.

Eight new research projects were also authorized for solicitation. Clear Roads also elected to form a subcommittee to manage the Clear Roads QPL (formally known as Pacific Northwest Snow fighters QPL).

FISCAL YEAR 2019 ACCOMPLISHMENTS

The Clear Roads pooled fund study completed six research projects and continued several other projects during the 2019 FY. These projects and their respective deliverables are described below.

13-05 Developing Test Bed Software to Qualify Plug and Play Technology

The goal of this project is to develop a software suite that will be used to validate and certify candidate spreader controllers and AVL equipment for compliance with the current Clear Roads Universal In-Cab Performance Specification and Communications Protocol.

14-03 Developing a Training Video and Manual for Best Practices and Techniques in Clearing Different Interchange Configurations and Other Geometric Layouts

This project was extended into FY 18. It will be a 15-20-minute video that showcases the most efficient pass sequences to properly clear various interchange and intersection layouts. MDOT plans to use this to instruct operators on the best way(s) to safely clear various intersection geometries.

15-01 Synthesis of Material Application Methodologies for Winter Operations

The goal of this project is to create a synthesis of best management practices for application rates, material application methodologies and material usage, including chloride brines applied directly or as additives to abrasives and rock salts.

16-01 Utilization of AVL/GPS Technology: Case Studies

The goal of this project is to help state DOTs make more informed decisions with respect to implementation of winter maintenance AVL/GPS. MDOT was one of the case studies highlighted in this report.

16-02 AWSSI Enhancements in Support of Winter Road Maintenance

The objective of this project is to expand on the current AWSSI Tool to add more stations and provide features to allow for winter severity projections and connect winter severity to winter maintenance costs.

16-05 Weather Event Reconstruction and Analysis Tool

The goal of this project is to allow transportation agencies to more quickly and easily reconstruct winter weather events, with a focus on drawing from data sources that cover the entire United States or large regions.

16-03: Standards and Guidance for Using Mobile Sensor Technology to Access Winter Road Conditions

Through rigorous testing of sensor equipment, development of standardized scales, and creation of guidance for using an array of measurements in concert for decision-making, Clear Roads will make better use of road sensor data than is now currently available.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

The Clear Roads pooled fund study plans to commence and continue several projects during the 2020 FY. These projects are described below.

- 18-04: Review and Summary of Pre-wet Methods and Procedures
- 18-03: Evaluation of SSI and WSI Variables
- 18-02: High Performance Blade Evaluation
- 18-01: Defensive Driving for Snowplow Operators
- 18-05: Alternative Methods for Deicing
- 17-01: Integrating Advanced Technologies into Winter Operations Decisions
- 17-03: Aftermarket Cameras in Winter Maintenance Vehicles
- 17-02: Standard Specifications for Plow Blades with Carbide Inserts

Clear Roads will also be revamping the Clear Roads Qualified Products List (QPL), formally known as the PNS QPL.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

This continuation project will maintain its focus on advancing winter highway operations nationally through practical, practice-ready research related to materials, equipment and methods. State departments of transportation are aggressively pursuing new technologies, practices, tools, and programs to improve winter highway operations and safety while maintaining fiscal responsibility.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Annual contribution is \$25,000 per state. With 36-member states, that's \$875,000 leveraged for investigator work on research projects, implementation and technology transfer activities, administrative management of the pooled fund, and travel expenses for member representatives to attend 2 Technical Advisory Committee meetings per year. State DOTs may use 100% federal funds to contribute to Clear Roads.

By participating on this pooled fund MDOT can:

- Inform the research agenda for Clear Roads by proposing topics for future projects.
- Help prioritize and select projects for funding.
- Evaluation technical proposals to conduct the research from academic and private-sector investigators.
- Serve on subcommittees that oversee research projects.
- Meet with experts from around the country on winter maintenance issues.
- Travel to TAC meetings with expenses paid by the pooled fund.

One of the most important aspects of Clear Roads membership is access to the Clear Roads members themselves and their expertise. Members often send inquiries to their member peers for quick turnaround information. They can then report back to their management within days and provide information based on actual experiences of member states. Those inquiries and the summary of the information they receive back from the states is posted on a members-only page on the Clear Roads website.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: ITS Pooled Fund Program (ENTERPRISE) Phase II

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(359)	MDOT START DATE	1/2/2018
PROJECT NO.	200188 / 204724 / 200858	MDOT COMPLETION DATE (Original)	11/30/2020
OR NO.	OR17-101 (a and b)	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Elise Feldpausch		
LEAD AGENCY:	Michigan Department of Transportation		
PROJECT MANAGER	Elise Feldpausch		
CONTRACTOR	CTC & Associates, Athey Creek Consultants LLC		

TOTAL PROJECT BUDGET ALLOCATION and EXPENDITURES

MDOT Project Total Budget			Project Total Budget		
FY 2019 MI-BUDGET	(Original)	\$35,000.00	TOTAL BUDGET	(Original)	\$1,825,000.00
FY 2019 MI-BUDGET	(Revised)		TOTAL BUDGET	(Revised)	\$927,328.29
TOTAL FY 2019 MDOT EXPENDITURES		\$35,000.00	TOTAL FY 2019 PROJECT EXPENDITURES		\$54,128.62

Year	Total MDOT Contributions	Project Total Expenditures
2017	\$35,000.00	\$0.00
2018	\$45,000.00	\$37,008.53
2019	\$35,000.00	\$261,671.45

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

SPR-II Funds: IL (10.8%), IA (14.6%), KS (10.8%), MI (12.6%), MN (10.8%), PA (12.4%), TX (17.1%) and WI (10.8%)

Non-SPR-II Funds: IA, Dutch Ministry of Transport, and Ontario

PURPOSE AND SCOPE

This new Transportation Pooled Fund (TPF) project is a continuation of TPF-5(231), titled, "ENTERPRISE Group," that was established in 1991. ENTERPRISE's main purpose is to develop and carry out a joint research program to develop, evaluate, and deploy Intelligent Transportation System (ITS) technologies. Each year, members contribute funds in support of ITS projects of mutual interest and develop an annual work plan. These projects typically involve private sector partners working with designated member agencies. Over time, ENTERPRISE has grown into a multi-national consortium dedicated to the advancement of ITS and provides a focus for coordinating ITS developments and for sharing results within and outside the program.

The Technical Advisory Committee (TAC) voted unanimously to perform future research activities, starting in 2017, under this new TPF project to be led administratively by MDOT. The tasks to be completed as part of the program vary from year to year and are reevaluated through an annual project selection process as established by the ENTERPRISE member agencies. Requests for proposals will be posted for contracts based on approved work plans and it is expected that several contracts may be authorized throughout the life of the pooled fund project.

Research objectives may include but are not limited to the following:

1. Investigate and promote ITS approaches and technologies that are compatible with other national and international ITS initiatives.
2. Support the individual ITS program plans of ENTERPRISE participants.
3. Provide a mechanism to support multi-state and international project cooperation and technical information interchange.
4. Facilitate the formation of public-private partnerships for appropriate program activities.
5. Pursue emerging ITS project opportunities in areas of interest to the group.
6. Provide test beds in a variety of environments and locations for emerging ITS technologies.
7. Identify common needs within the group and proceed with appropriate technical activities.

Administration Contract (OR17-101b): This sub project is for administrative services and technical advisement. Primary services required will be management of related research projects including tasks such as project tracking, organization of monthly meetings, completion of FHWA quarterly reports and closeout funding spreadsheet, and preliminary scope and estimates.

Research Contract (OR17-101a): The overall goal of this sub project is to carry out joint research to develop, evaluation and deploy ITS.

The following table shows SPR II and non-SPR II funding and contract expenditures for this project:

OR No.	Funding Source	FY 19 Expenditures	Total Expenditures	Total Budget
OR17-101b	SPR II - JN 200188	\$54,128.62	\$91,137.15	\$149,874.06
OR17-101a	SPR II - JN 204724	\$207,542.83	\$207,542.83	\$501,834.38
OR17-101a	Non-SPR II – JN 200858	\$0.00	\$0.00	\$207,467.00
Commitments/Contributions that have not been allocated to a specific contract:				\$58,274.04
TOTALS		\$261,671.45	\$298,679.98	\$917,449.48

FISCAL YEAR 2017 ACCOMPLISHMENTS

Completed solicitation for partners and determined priorities for starting the project. Developed problem statements, posted Requests for Proposals (RFPs) and scored proposals received for the following contract authorization: Administrative Services and Technical Advisement [OR17-101b].

FISCAL YEAR 2018 ACCOMPLISHMENTS

OR17-101b:

Announced selection for the administrative contract authorization of the ENTERPRISE Phase II project. Held the initial kick off meeting with the TAC and administrative consultant (OR17-101b) to begin developing the annual work plan. Post Requests for Proposals and scored proposals received for the following contract authorization: Research Objectives (OR17-101a).

OR17-101a:

TAC Meeting held on September 19, 2018. TAC reviewed and approved the RFP draft for posting solicitation to secure research vendor for performing initial research objectives.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The project kick-off meeting with the TAC and Athey Creek (OR17-101a) was held November 14-15, 2018. The TAC developed a plan for five primary research projects to get underway and discussed options for six secondary projects. The five primary projects began between November 2018 and February 2019. Three secondary projects were scoped in the 4th quarter of the fiscal year.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

The five primary projects will end in 1st/2nd quarters of the FY. Three secondary projects will be started in October 2019. Four additional secondary projects will be scoped in October 2019 so work can begin in the 2nd quarter of FY20. Potential new projects will be discussed in March 2020.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion in FY 2020.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Evaluation of .7-inch Diameter Carbon Fiber Reinforced Polymer Pretensioning Strands in Prestressed Beams

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(363)	MDOT START DATE	12/5/2017
PROJECT NO.	201029	MDOT COMPLETION DATE (Original)	9/30/2020
OR NO.	OR15-541	COMPLETION DATE (Revised)	
TECHNICAL CONTACT	Eric Munley Eric.Munley@dot.gov Phone: 202-493-3046		
LEAD AGENCY	Michigan Department of Transportation		
PROJECT MANAGER	Steve Kahl		
CONTRACTOR	Lawrence Technological University		

BUDGET STATUS

FY 2019 MDOT Budget			Total Budget		
FY 2019 MI-BUDGET	(Original)	\$24,935.00	TOTAL BUDGET	(Original)	\$358,733.00
FY 2019 MI-BUDGET	(Revised)			(Revised)	
TOTAL FY 2019 MDOT EXPENDITURES		\$24,934.71	Total Obligated Funds		\$336,732.94

Year	Total MDOT Contributions	Project Total Expenditures
2017	\$36,000.00	\$0.00
2018	\$75,798.26	\$78,279.51
2019	\$24,934.71	\$71,063.54

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

ME (25.3%-Not yet recd.), MI (28.7%), NC (23%), and OH (23%)

PURPOSE AND SCOPE

The proposed research is necessary to evaluate the safe use of 0.7-inch diameter Carbon Fiber Reinforced Polymer (CFRP) strands in a beam to meet load carrying requirements. This study will evaluate material properties, details, and design criteria to use 0.7-inch diameter CFRP strands for pre-tensioning of pre-stressed AASHTO I girders, bulb-T, and box beams. The study will include a look at the performance of the strands for environmental conditions and extreme events, as well as prepare design procedures and examples. Project deliverables include construction specifications for 0.7-inch CFRP strands. The research results will identify fabrication concerns with the larger diameter strands as well.

FISCAL YEAR 2017 ACCOMPLISHMENTS

The solicitation process for this project was completed, a vendor was selected, and a contract was awarded to Lawrence Technological University (LTU) to perform the research services.

FISCAL YEAR 2018 ACCOMPLISHMENTS

Task #1: Literature review: The research team finalized the main sections of the literature review and summarized the main points of concern and those needing further investigation.

Task #3: High temp/freeze-thaw: The research team tested the first batch of carbon fiber composite cable (CFCC) specimens under 150 cycles of freeze and thaw. The research team is currently preparing for the second batch that will be subjected to 300. The research team also studied the effect of high temperature on the tensile strength of CFCC through heating and testing to failure multiple 6-ft long CFCC test specimens.

Task #4: Creep/relaxation/prestress loss: The test specimens for creep and relaxation are currently under continuous monitoring. In addition, the research team evaluated and presented to MDOT Engineers the loss of the prestressing force in 48-ft long CFCC strands anchored using three wedge anchors and coupler system during the construction of beam specimens for fire testing (Task #6).

Task #5: Transfer & development length: The research team prepared and tested three batches of test specimens to evaluate the transfer and development lengths.

Task #6: Precast beams under fire/freeze-thaw: The research team completed the construction of all beams necessary for fire testing and is currently preparing and conditioning the fire chamber to conduct the fire test after the moisture in the beams drops to an

acceptable testing levels to avoid concrete spalling and premature failure of the beams. In addition, the research team is currently building the formwork and the reinforcement cages for the freeze-thaw beams. After these beams are built, they will be subjected to 300 cycles of freezing and thawing and then tested to failure under flexural loading to determine the residual strength and the mode of failure.

The 2018 Technical Advisory Committee (TAC) meeting was held on September 13-14, 2018.

FISCAL YEAR 2019 ACCOMPLISHMENTS

Task #4: Test specimens for creep and relaxation have been under continuous monitoring since the start of the project. The research team evaluated the prestress loss in relaxation specimens and performed the necessary maintenance on the test setup to ensure that the creep specimens are still subjected to a constant load level.

Task # 5: The research team continued to test the new set of pull-out specimens that contained diameters of steel and CFCC strands to compare the bond strength between CFCC and steel strands. Based on these test results, bond capacity between CFCC and concrete is approximately 150 percent of the capacity between steel and concrete. Bond specimens were also prepared for extreme heat and extreme cold testing. Five pull-out bond specimens will be subjected to cycles of elevated temperature, while five will be subjected to cycles of freezing and thawing. After concluding the cycles of high temperatures or freezing/thawing, the specimens will be subjected to static pull-out test to evaluate the effect of temperature increase/decrease on the bond strength between CFCC and concrete.

Task # 7: Testing of full-scale beams included fire testing of beam specimens in the fire chamber and included building two more beam specimens for a complete bridge model. During the last quarter, the fire testing continued, and two more full-scale beam specimens were tested under fire. The first beam specimen was prestressed with CFCC strands, while the second beam specimen was prestressed with steel strands. The fire endurance of a beam with CFCC strands was approximately 50 percent of that for the beam with steel strands. Failure took place due to the loss of bond between CFCC and concrete. Nevertheless, the beam with CFCC strands supported the applied load for two hours under fire conditions. In addition, the research team is currently working on constructing four half-scale beams that will be used to build a bridge model that will also be tested under flexural loading setup. The test results of the bridge model will be compared with the results obtained in 2013 from testing an identical model with 0.6-inch CFCC strands (under different MDOT research project).

Task #9 The research team performed the analysis of test results to date and started developing analytical models to compare the experimental test results with the analytical estimate. The team also performed completed thermal heating and cooling tests on the freeze-thaw beams and is preparing to start the freeze-thaw cycles.

The 2019 TAC meeting was planned for October 7 and 8; however, the Principal Investigator (PI) cancelled this meeting due to a medical emergency.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project completion expected in FY 2020.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Performance Engineered Concrete Paving Mixtures

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(368)	MDOT START DATE	1/1/2017
PROJECT NO.		MDOT COMPLETION DATE (Original)	12/31/2021
OR NO.	OR18-009	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	John Staton, 517-322-5701 StatonJ@michigan.gov		
LEAD AGENCY:	Iowa Department of Transportation		
PROJECT MANAGER	Khyle Clute, 515-239-1646 Khyle.Clute@iowadot.us		
CONTRACTOR	Iowa State University: Mr. Peter Taylor 517-294-9333		

BUDGET STATUS

FY 2019 Budget			Total Budget		
FY FUNDS	(Original)	\$15,000.00	TOTAL COST	(Original)	\$75,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$15,000.00	Total Committed Funds Available		\$30,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

CO, FHWA, IA, ID, IL, KS, MI, NC, NY, OH, PA, SD, WI

PURPOSE AND SCOPE

The objective of this study is to focus on the successful deployment of Performance Engineered Mixtures (PEM). This study will build upon foundational work supported by FHWA as well as states participating in this study. Emphasis will be placed on implementation, education and training, adjusting the specification values to relate accurately to good pavement performance in the field, and continued development of relating early age concrete properties to performance.

Task 1: Implementing What We Know

This task is intended to provide support to study participants with implementation of performance engineered paving mixtures within their states.

Task 2: Performance Monitoring and Specification Refinement

With any new specification it is critical to monitor the requirements and be sure that they are optimized to consistently produce good performing pavements. As necessary, the specification values and testing limits should be adjusted to represent the optimal balance between cost and performance. This task will provide field performance data for use in making decisions on specification limits in the areas of salt damage, transport and freeze-thaw damage.

To accomplish this successfully, an organized process of pavement monitoring and evaluation is intended in this task. It is proposed that the projects built under PEM specification requirements also continue to be monitored in the future Phase 2 of the study.

Task 3: Measuring and Relating Early Age Concrete Properties to Performance

This task will build upon the foundational work done to date in measurement technologies to design and control concrete pavement mixtures around key engineering properties.

It is planned that work under this task will address Improved testing methods for improved accuracy and reduced cost.

FISCAL YEAR 2017 ACCOMPLISHMENTS

The following are ongoing activities for 2017 included as task 1 of this study.

Project Level Support (shadow testing and pilot projects)

- FHWA Mobile Concrete Trailer (MCT) – FHWA began support of four or five projects per year with testing and training of state and contractor personnel on the projects. All states participating in the PFS will have the opportunity for the MCT support. The Concrete Pavement (CP) Tech will coordinate field support with the FHWA MCT and provide project assistance with running field tests and be available to work with DOTs on assistance with mixture qualification tests. Assist running test procedures and incorporating them into state specifications. Michigan was not on the list of states to be visited in 2017.
- A session at each of the spring and fall 2017 NCC meetings will provide an update on the project.
- Initial PEM presentations are available at:
 - <http://www.cptechcenter.org/ncc/TTCC-NCC-2017.cfm>;
 - http://www.cptechcenter.org/ncc/TTCC-NCC-documents/F2017NC2_Docs/2%20Cackler-NCC%20PEM%20Introduction2%20091917.pdf;
 - <http://www.cptechcenter.org/ncc/2017%20Spring%20NC2/24%20PRAUL%20-%20PEM.pdf>;

- <http://www.cptechcenter.org/ncc/2017%20Spring%20NC2/25%20Jones%20PEM.pdf>
- A suite of prospective standard test procedures will be proposed for the new testing methods as DOTs work with the research team to validate the test procedures and incorporate them in appropriate mixture qualification and construction specifications, as follows:
 - Shrinkage Tests:
 - <http://www.cptechcenter.org/ncc/2017%20Spring%20NC2/28%20Weiss-NCC-Shrinkage.pdf>
 - <http://www.cptechcenter.org/ncc/2017%20Spring%20NC2/27%20Jafar%20shrinkage.pdf>
 - Super Air Meter (SAM)
 - Determination of F Factor using electrical methods and mixture constituent properties
 - Vibrating Kelly Ball (VKelly)
 - Dual Ring
 - Oxychloride methods
 - Box Test

FISCAL YEAR 2018 ACCOMPLISHMENTS

PEM Team members provided a PEM update at the National Concrete Consortium (NC2) spring meeting at Couer d'Alene, ID in April. The PEM TAC joined for a conference call on May 11, 2018. Topics discussed included PEM progress, tests/testing updates, data collection protocol and progress in preparation of PP-84-19, (Standard Practice for Developing Performance Engineered Concrete Pavement Mixtures).

CP Tech Center staff delivered a PEM update to the ACPA Chapter/State Paving Association Executives at their spring meeting in Skamania, WA. Participants discussed how they might work with contractor members toward implementation of the PEM tests and procedures.

On May 17, 2018, PEM Team members collaborated with the FHWA MCT lab personnel and the CO/WY Chapter – ACPA to present an open house on a paving project near Denver. The PEM tests were demonstrated by FHWA and CP Tech Center staff. Nearly 60 people attended the event with representation from agency, engineering companies and industry.

CP Tech Center staff joined ACPA contractors and associates at the Association's Strategic Board meeting in Denver in June. They addressed the group with an overview of the PEM initiative and participated in an open forum discussion about PEM with concrete paving contractors from across the nation. A primary objective of the meeting was to identify contractor needs related to PEM.

PEM Team members worked throughout the quarter, refining and responding to industry comments as they prepared the PP-84-19 that is due in the hands of the AASHTO COMP Technical Conversations continue with state DOT participants to identify and respond to their needs, questions and plans for PEM shadow testing. Activity is anticipated in MN, IA, PA, and SD during the 2018 construction season. Currently, NC, NY and ID are discussing events/training/shadow testing for 2019. PEM Team members continue additional outreach with the states.

The PEM Website was launched this quarter through the CP Tech Center. Users will find valuable information about PEM, test method summaries, videos, slideshows or You Tube links, a schedule of shadow project and information pertinent to test data entry. The link is www.cptechcenter.org/pem.

FISCAL YEAR 2019 ACCOMPLISHMENTS

PEM open houses were held with the FHWA MCT lab in MN (July 18) and IA (August 1)

- Revisions to PP-84-19 were balloted in the fall 2019 AASHTO COMP Rolling Ballot.
- Shadow testing was completed in SD in September on I-90 in western SD
- Training and open houses were completed in PA in late August
- PEM update for the PCA at their August meeting in Minneapolis, MN
- PEM updates and agency presentations at the NC2 meeting in Denver, CO (spring 2019) and Kalispell, MT (fall 2019)
- Outreach and assistance to SHA and industry
- Continued effort to expand participation in the study

FISCAL YEAR 2020 PROPOSED ACTIVITIES

- Annual PEM TAC meeting held in Minneapolis, MN November 18-19, 2019
- Collect, Collate, and publish field data from four states
- Mine LTPP database
- Provide updates at AASHTO COMP meeting in Miami, FL on August 2-6, 2020
- Revise TP's/PP-84 from fall 2019 COMP rolling ballot for April 2020 AASHTO Materials Standard publication

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

During the late summer of 2015 and the 2016 paving season, agencies (Illinois, Indiana, Iowa, Nebraska, Michigan, Minnesota, Wisconsin, South Dakota, Manitoba, and the Illinois Tollway) started using and evaluating new testing technologies that support the design and testing of performance engineered concrete paving mixtures (PEMs).

A proposed AASHTO provisional specification and commentary was submitted for balloting by the member states. This specification seeks to provide agencies with the tools to prepare a specification for concrete mixtures for pavements that moves closer to measuring and basing acceptance on the parameters that are truly critical to the long-term performance of the system.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Building Information Modeling (BIM) for Bridges and Structures

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(372)	MDOT START DATE	10/1/2017
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/30/2022
OR NO.	OR18-017	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Brad Wagner, 517-256-6451 WagnerB@michigan.gov		
LEAD AGENCY:	Iowa DOT		
PROJECT MANAGER	Khyle Clute, 515-239-1646 Khyle.Clute@iowadot.us		
CONTRACTOR			

BUDGET STATUS

FY 2019 Budget			Total Budget		
FY FUNDS	(Original)	\$20,000.00	TOTAL COST	(Original)	\$100,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$20,000.00	Total Committed Funds Available		\$80,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

CA , DE , FHWA , IA , IL , KS , MI , MS , NC , NJ , NY , OH , PA , TX , UT , WI

PURPOSE AND SCOPE

The pooled fund project will provide the primary funding mechanism for AASHTO SCOBS T-19 to perform the duties of governance and stewardship of BIM for Bridges and Structures.

1. Establish standards, guidelines, or manuals for bridge project stakeholders to facilitate the wide use of IFC as an exchange standard in BIM for Bridges and Structures in bridge projects. This would include recommending or mandating the use of common modeling format and IFC submittal.

2. Develop the national standard MVD, data definitions, and data requirements for the model life cycle for all data exchanges for transportation bridges and structures. This national standard will use the above governance and stewardship model to facilitate the development and future maintenance.

3. Collaborate with stakeholders to provide timely update of IFC data dictionary for common bridge elements.

4. Collaborate with building SMART and software vendors to design and offer suitable training covering BIM for Bridges and Structures model development, management, and usage.

5. Conduct return on investment (ROI) analysis to quantify the benefits of using a common modeling format, BIM for Bridges and Structures, in terms of time and cost savings.

6. Develop a template of BIM for Bridges and Structures-specific contractual provisions for managing, reducing, or eliminating the risks associated with IFC-BIM for Bridges and Structures. Project stakeholders/owners could use the template to conduct a risk evaluation for deploying BIM for Bridges and Structures at a project and organization level.

7. Provide recommendations to T-19 on changing existing workflows to leverage model exchanges for project delivery and asset management for transportation bridges and structures owners.

8. Provide a work plan, progression schedule, and coordination web and face to face meetings with T-19 on the development and implementation of BIM for Bridges and Structures.

9. Establish a forum/expert hub for practitioners in the bridge industry to promote the common modeling formats and share experiences.

10. Provide technical support, organize training workshops, and facilitate pilot/demonstration projects for bridge owners to encourage and accelerate the adoption of BIM for Bridges and Structures.

Comments:

It is envisioned that the tasks listed above will be contracted to a consultant with proven expertise in this area.

FISCAL YEAR 2018 ACCOMPLISHMENTS

During FY 2018, an initiation meeting was held to get input from industry and to refine the project request for proposals. The project was advertised, and a preferred vendor was selected. Currently, the first-year work plan is being negotiated in order to authorize the consultant. Expected authorization will be October 2018.

FISCAL YEAR 2019 ACCOMPLISHMENTS

During FY 2019, the researchers documented existing BIM efforts and formed working groups to carry out various activities associated with the pooled fund. Accomplishments include development of a website to support BIM education and overall engagement, submitted a draft report documenting existing BIM efforts and common terminology, updated the bridge lifecycle process map to reflect current needs, and developed an overall engagement/outreach plan.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

During FY 2020 the team will complete a gap analysis comparing the current MVD for Design to Construction with the international Bridge Design Transfer View MVD. Software testing will be conducted to test the MVD, and a final MVD will be delivered. The collaboration site will be launched.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MDOT identified payoff potential and implementation planned is as follows:

1. MDOT will use the study results to assist in developing standards for 3D bridge modeling
2. Manage risks associated with 3D models by utilizing developed contractual templates
3. Make changes to existing workflows to leverage model data exchanges over the life of the bridge
4. Participate in available training.

RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019

STUDY TITLE: National Partnership to Determine the Life Extending Benefit Curves of Pavement Preservation Techniques
(MnROAD/NCAT Joint Study – Phase II)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(375)	MDOT START DATE	1/2/2019
PROJECT NO.		MDOT COMPLETION DATE (Original)	12/31/2023
OR NO.	OR19-203	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Curtis Bleech 517-636-4955 BleechC@michigan.gov		
LEAD AGENCY:	Minnesota Department of Transportation		
PROJECT MANAGER	Ben Worel 763-381-2130 ben.worel@state.mn.us		
CONTRACTOR			

BUDGET STATUS

FY 2019 Budget			Total Budget		
FY FUNDS	(Original)	\$50,000.00	TOTAL COST	(Original)	\$250,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$50,000.00	Total Committed Funds Available		\$200,000.00

PARTICIPATING STATES

ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.

AL,AR,CO,FHWA,FP2,GADOT,IL,KS,KY,MDOT SHA,MI,MN,MO,MS,NC,NY,OK,PADOT,SC,TN,TX,WI,WV

PURPOSE AND SCOPE

Main objectives include:

1. Determining the life cycle cost of various pavement preservation alternatives in a highly controlled experiment that will provide state Departments of Transportation (DOTs) with the financial foundation to begin to build a decision tree for their own maintenance program
2. Develop quality assurance QA field testing protocols to correlate construction practices with long term performance of pavement preservation techniques.
3. Technology transfer - Answering practical questions posed by research sponsors through formal (i.e., reports & technical papers) & informal (e.g., one-on-one responses to sponsor inquiries) technology transfer on how these life extending benefits can be best utilized in each state.

This second phase (2019-2024) will be used to continue to monitor and analyze data from the low and high volume pavement preservation sections built both in Alabama and Minnesota since many of the test sections were built in 2016 and not had enough time to show what rate of deterioration they will have. MnDOT will lead this portion of the pooled fund study and will again partner with NCAT but now they will be the subcontractor doing the data collection in Alabama and the majority of the data analysis.

Activities that are expected include: Continue Data Collection of each of the test sections both in Alabama and Minnesota utilizing common methods and equipment between all four locations.

FISCAL YEAR 2019 ACCOMPLISHMENTS

PR outreach for new members to join the pooled fund study. Monitoring of various test sections including data collection, analyzation and reporting out of findings. Technical transfer efforts continue with presentations to various DOT's and organizations on current best practices and latest technologies.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Continued PR outreach and technical transfer of findings and solicitation of national innovations for such technology transfer. Continual efforts of data gathering, analyzation and reporting of findings from the various test sections that have been constructed at the test track and off-site. Initial development of QA protocols to correlate construction practices with actual performance. Data collection and analyzation for life cycle cost analysis purposes.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Implantables are in the form of recommendations from the reporting out of the findings, informational webinars, and Technology Transfer Sessions on a variety of subject matter. The findings may allow DOT's to have research to support specification changes, implement fixes not commonly used or tried in a particular state, and validation of fixes and methods used. Results of performance along with initial costs will allow for life cycle costs analysis. This analysis will allow road agency's to make informed cost decisions on future project selection as it relates to their available budgets and network pavement condition.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Print

Technology Exchange on Low Volume Road Design, Construction and Maintenance

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(379)	MDOT START DATE	10/1/2018
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/30/2021
OR NO.	OR19-207	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Tracie Leix 517-335-2233 LeixT@michigan.gov		
LEAD AGENCY:	Iowa Department of Transportation		
PROJECT MANAGER	Khyle Clute 515-239-1646 Khyle.Clute@iowadot.us		
CONTRACTOR			

BUDGET STATUS					
FY 2019 Budget			Total Budget		
FY FUNDS	(Original)	\$10,000.00	TOTAL COST	(Original)	\$10,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$10,000.00	Total Committed Funds Available		\$0.00

PARTICIPATING STATES	
ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.	
AK,IADOT,IL,KS,LA,MI,OH,UT,VA,WI	

PURPOSE AND SCOPE

The primary activities of this pooled fund project are technology exchange, information sharing, and the facilitation of partnering relationships among state agencies and participating members with FHWA, Local Public Agencies and other appropriate agencies and associations. Technology exchange activities in conjunction with the 12th International Conference on Low Volume Roads will be advantageous to participating members. Specifically, this pooled fund will:

1. Provide communication and information sharing among member participants: Discuss research, development and technology transfer needs in the areas of design, construction, maintenance, and safety on low volume roads and provide research ideas to TRB in the areas of Low Volume Roads.
2. Member workshop at the 12th International Conference on Low Volume Roads: Provide a technology and knowledge exchange forum to enhance the practical knowledge of pooled fund participants concerning low volume road management with a focus on encouraging State DOT and other agency participation in the pooled fund.
3. Pooled Fund Member Meeting on Low Volume Road Issues: Provide a technology and knowledge exchange forum focused on Low Volume Road issues. Topics may include agency collaboration, funding, asset management, shared ROW/utilities, safety programs, emergency response, training and certifications, maintenance of traffic, federal oversight, standards and specifications, contracting methods, environmental issues, energy development, maintenance, material sources and quality, and bonding.
4. Technology Transfer through paper publication and webinars on topics selected by pooled fund member in areas of Low Volume Road Design and Management

The Iowa Department of Transportation (Iowa DOT) will serve as lead state for the execution of this Pooled Fund project. TRB will facilitate all administrative duties associated with the project and will invoice the Iowa DOT for reimbursement up to the amount available in the Pooled Fund.

The principle tasks are:

1. TRB will organize arrangements for the Low Volume Road pooled fund member agencies for the technology exchange on best practices in management of Low Volume Roads. The pooled fund will help support the travel and per diem expenses of pooled fund members associated with the technology exchange. This will include expenses to attend the 12th International Conference on Low Volume Roads. It is anticipated that individuals from pooled fund partner members may be invited to participate on the Conference Planning Committee calls to coordinate technology exchange events with the conference. These calls will help in coordinating the activities during the conference as determined by participating member agencies.

2. Meeting for Agencies – TRB will provide for a learning session and technology exchange forum to be held during the conference at the same venue as the conference. The intent will be for pooled fund partners and other invited agencies plus invited speakers to discuss member agency issues related to Low Volume Roads. This is an opportunity for the pooled fund partners to collaborate and

share best practices and strategies for overcoming certain challenges. The exchange forum will be held during the conference due to the anticipated opportunity to interact with experts and other technical professionals at the conference. The Iowa DOT will coordinate the learning session with other pooled fund partners. The Conference Planning Committee will not be involved in planning the pooled fund partner session, though collaboration is expected on venue accommodations and conference program planning. TRB will synchronize the conference and pooled fund member activities to allow pooled fund members to accomplish its business and technology deployment goals while also providing opportunity to participate in key components of the international conference.

3. If funds allow, follow-up post conference webinars will be organized by pooled fund partners and led by TRB for dissemination and execution. The webinars will share highlights from activities and include an open forum question/answer discussion or it may be to highlight the best papers of presentation that pooled fund members find of interest from the conference. In addition, pooled fund member agencies will review topics and projects through a selection process and select those worthy of dissemination through publications. (vi) Collect data on at least 100 miles of interstate or primary type pavements for each year of participation with the option to include additional testing at additional commitment levels.

(vii) Organize and deliver workshops and training material for the consortium members.

The pooled-fund project will be led by the Virginia Department of Transportation (VDOT) through its research office, the Virginia Transportation Research Council (VTRC).

FISCAL YEAR 2019 ACCOMPLISHMENTS

Was involved in two panel discussions on the State of Michigan Local Bridge Program with nine other states. Found that how states handle their local bridges vary significantly. Michigan's Local Bridge Program in one of the few states involved that had a dedicated funding source for local bridges and has a more defined process on how the funding is distributed.

Of the ten states, Virginia had jurisdiction of all local bridges and made the decisions on which bridge have work done. Michigan, on the other end of the spectrum, has local bridges under local jurisdiction. Most of the other states oversee work on local bridges but may not own the structures.

Of the ten states involved in the panel discussions, Michigan puts more money toward local bridge than most.

Information gathered and shared on safety and mobility considerations for detour routes on remote/low volume roads. Low volume CAV topics discussed, and information shared with MDOT staff.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

N/A

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Using Michigan's Local Bridge Program as a model for other states to follow, at least for states where local agencies have jurisdiction, is recommended. It's suggested that an MDOT representative give additional presentations about the Local Bridge Program and how it operates. Resources and information will be shared with local agencies.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Pavement Structural Evaluation with Traffic Speed Deflection Devices (TSDD's)

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(385)	MDOT START DATE	3/1/2019
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/30/2021
OR NO.	OR19-205	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Paul Shapter 517-243-7739 ShapterP@michigan.gov		
LEAD AGENCY:	Virginia Department of Transportation		
PROJECT MANAGER	Bill Kelsh Bill.Kelsh@VDOT.Virginia.gov		
CONTRACTOR			

BUDGET STATUS					
FY 2019 Budget			Total Budget		
FY FUNDS	(Original)	\$45,000.00	TOTAL COST	(Original)	\$135,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$45,000.00	Total Committed Funds Available		\$90,000.00

PARTICIPATING STATES	
ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.	
Louisiana Transportation Research Center, AR, FHWA, GADOT, ID, IL, IN, KS, KY, LA, MI, MN, MS, NC, NM, OK, PADOT, SC, TN, TX, VA, VT	

PURPOSE AND SCOPE

The objective of the proposed pooled-fund project is to establish a research consortium focused on providing participating agencies guidelines on how to specify collection and use data collected with TSDDs for network- and project-level (if feasible) pavement management applications. Specific tasks within this multi-year program will be developed in cooperation with the consortium participants. In addition, the consortium will also provide participating agencies with a mechanism to conduct pilot demonstration testing in their respective networks.

The work plan will be developed based on the priorities indicated by the consortium participants, during the kick-off meeting. It is anticipated that the details and scope of the objectives will be further defined to reflect the concerns of the consortium participants. However, it is proposed that the project will include the following tasks:

- (i) Develop a list of available devices and their characteristics. This will include details about the number of devices currently in operation and what type of data they collect.
- (ii) Develop data collection guidelines and specifications for agencies. This will include reviewing best practices from around the world and will be coordinated with service providers to ensure proposed guidelines can be implemented.
- (iii) Develop guidelines on how to incorporate pavement structural condition data into agency network-level pavement business processes. This will include defining what structural indices to use and investigating how the structural condition data can complement currently collected surface condition data to make better decisions.
- (iv) Demonstrate how structural condition collected from TSDDs can be used for supporting project level decision-making based on case studies.
- (v) Demonstrate the costs effectiveness of collecting structural condition data both, at the network and project levels, through case studies.
- (vi) Collect data on at least 100 miles of interstate or primary type pavements for each year of participation with the option to include additional testing at additional commitment levels.
- (vii) Organize and deliver workshops and training material for the consortium members.

The pooled-fund project will be led by the Virginia Department of Transportation (VDOT) through its research office, the Virginia Transportation Research Council (VTRC).

FISCAL YEAR 2019 ACCOMPLISHMENTS

2019 Accomplishments

- 13 states have collected data.
- Some states had additional testing performed
- The pool fund held a meeting and conference to go over data and activities
- Developed route for collection

FISCAL YEAR 2020 PROPOSED ACTIVITIES

2020 Proposed activities

- Work on developing TSDD calibration
- Work on incorporating structural data into network pavement management

-
- Develop route for additional collection
 - Attend pool fund annual meeting and conference

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Project expected completion FY 2021.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Development of an Integrated Unmanned Aerial Systems (UAS) Validation Center

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(387)	MDOT START DATE	9/1/2018
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/1/2021
OR NO.	OR19-200	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Brian Zakrzewski ZakrzewskiB@michigan.gov		
LEAD AGENCY:	Indiana Department of Transportation		
PROJECT MANAGER	Anne Rearick 317-232-5152 arearick@indot.in.gov		
CONTRACTOR			

BUDGET STATUS					
FY 2019 Budget			Total Budget		
FY FUNDS	(Original)	\$25,000.00	TOTAL COST	(Original)	\$75,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$25,000.00	Total Committed Funds Available		\$50,000.00

PARTICIPATING STATES					
ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.					
DE,GADOT,IL,MI,MN,PADOT,UT,VA					

PURPOSE AND SCOPE

This pooled-fund study proposes to develop the standards, protocols, and testing requirements that a given Unmanned Aerial System (UAS) must meet and demonstrate for a given application.

Objectives Regarding Deployment:

- Access/address any safety concerns or issues regarding constrained locations where line of site is limited
- Research imaging system performance in poorly lit environments
- Control of the UAS while flying between large steel girders
- Address adequate resolution of the imaging system for detecting the damage of interest

The objectives of the study are two-fold:

- Development of the specific criteria a given UAS must meet for each specific application
- Determining how to validate that a given UAS meets the required criteria

The current industry is unregulated with regards to establishing the required level of performance for UAS in civil engineering applications. The results of this study will be the development of the performance measures and validation criteria that agencies can use when making decisions about deployment of UAS in the context of civil engineering.

The following project tasks are proposed:

Identify areas that need UAS validation in the context of civil engineering infrastructure. Possibilities include bridge and traffic signal inspection, accident reconstruction, construction site monitoring, site assessment and inspection of railroad way.

Conduct stakeholder workshops, including owners, engineers, pilots, and academics, to identify performance criteria which UAS must meet for a given applications.

Develop methodologies to "test" whether the UAS meets specific criteria identified in Task II for given applications.

These include, but are not limited to the following:

- The development of pilot and UAS navigation testing and validation obstacle courses, communication with the airport tower, filing of the flight-plan, as well as the required written testing criteria for the pilot.
- The development of camera and other sensor accuracy and precision requirements, such as lighting standards, contrast detection, color sensing capabilities, distance and volume measurement requirements, and image quality standards.
- The development of test methods and test equipment to objectively, and consistently measure that a given UAS is providing enough lighting (i.e., do small light optic measurement devices need to be installed at strategic locations under the bridge). Other devices to will need to be developed to ensure standard contrast testing, accuracy and precision standards, etc. required in the bullet item above can be quantitatively and repeatedly evaluated.
- The development of a test bed (e.g., full-scale bridge specimens, accident scenarios, etc.) in which navigation skills of the UAS are tested under specific conditions, such as a pre-defined wind speed.
- The development of UAS performance criteria when communication or line-of-sight is lost.

- Conduct stakeholder workshops to present results and refine as necessary.
- Conduct a beta version roll-out of the validation criteria at Purdue University's Center for Aging Infrastructure (CAI) and the Steel Bridge Research, Inspection, Training, and Engineering Center (S-BRITE).
- Based on results; further revise the validation criteria and submit a final report with detailed UAS performance measures and guidance for specific applications.
- Provide testing using the performance criteria developed and issue "certificates of performance" to UAS which satisfactorily meet the performance criteria testing for specific applications.

FISCAL YEAR 2019 ACCOMPLISHMENTS

The project kick-off meeting was held on January 9th, 2019. Literature review continued and several owners/users of UAS have been contacted to obtain their perspective on the use of UAS. The preliminary testing protocols for testing the capability of UAS began. Efforts are underway to develop the pilot and sensing evaluation criteria.

The project is a bit behind scheduled since the graduate student who initially working on the project in the fall had to leave Purdue University for personal issues. This set the research team back a few months in searching for a new student and getting that individual up to speed on the project. Additionally, the structural engineering student who then joined the project has decided to pursue an MBA and will no longer be part of the project. This is the second student to leave the project which obviously has a negative impact on the project. Dr. Connor is seeking a new student at this time.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Continue with the development of testing protocols. Complete concrete deck specimens with defects to evaluate the feasibility of creating such specimens for use in evaluating the capability of various UAS to detect and quantify such damage. Continue development of the pilot and sensing evaluation criteria. Evaluate implementation possibilities.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

Expected project completion in fiscal year 2021.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Connected Vehicle Pooled Fund Study					
FUNDING SOURCE: <input checked="" type="checkbox"/> FHWA <input type="checkbox"/> OTHER (PLEASE EXPLAIN)					
TPF NO.	TPF-5(389)		MDOT START DATE	10/1/2018	
PROJECT NO.	New Solicitation 1479		MDOT COMPLETION DATE (Original)	6/30/2020	
OR NO.	OR09-146		COMPLETION DATE (Revised)	9/30/2021	
MDOT TECHNICAL CONTACT	Collin Castle, 517-636-0715 CastleC@michigan.gov				
LEAD AGENCY:	Virginia Department of Transportation				
PROJECT MANAGER	Michael Fontaine, 434-293-1982 Michael.Fontaine@VDOT.Virginia.gov				
CONTRACTOR					
BUDGET STATUS					
FY 2019 MDOT Budget			MDOT Total Budget		
FY FUNDS	(Original)	\$50,000.00	TOTAL BUDGET	(Original)	\$100,000.00
	(Revised)	\$0.00		(Revised)	
TOTAL FY 2019 EXPENDITURES		\$0.00	TOTAL COMMITTED FUNDS AVAILABLE		\$100,000.00
PARTICIPATING STATES					
ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.					
AZ, CA, FL, MI, MN, NJ, NY, PA, TX, UT, VA, WA, WI					
PURPOSE AND SCOPE					
This project is a continuation of TPF-5(206).					
<p>To guide transportation agency involvement in connected vehicle deployments, AASHTO developed a Strategic Plan and Connected Vehicle Field Infrastructure Footprint Analysis to aid the owners and operators in the nationwide deployment of the connected vehicle infrastructure. USDOT has also produced guidance documents for deploying and supporting connected vehicle technology. While great strides have been made over the last decade, it is clear that research is still needed to develop, field-test, and perform technology transfer for applications that will make full use of the connected vehicle environment.</p> <p>The Connected Vehicle Pooled Fund Study (CV PFS) acts as a continuation of the Research Program to Support the Research, Development, and Deployment of System Operations Applications of Vehicle Infrastructure Integration (VII) (TPF-5(206)). TPF-5(206) was initiated in 2009 and was active for nearly 10 years. During that time, the program has been successful in its pursuit to provide technology transfer to aid transportation agencies and OEMs in justifying and promoting the connected vehicle environment and applications through modeling, development, engineering and planning activities. As of May 2018, eleven research projects have been completed and four additional projects are currently underway. The new CV PFS will continue the work of TPF-5(206) after that project ends.</p>					
FISCAL YEAR 2019 ACCOMPLISHMENTS					
Set up TAC Prepare state partners to program and be prepared to transfer their initial pledged funds starting in FY 2019 or 2020.					
FISCAL YEAR 2020 ROPOSED ACTIVITIES					
MDOT transfer FY 2020 federal funds and assign a technical contact person on the TPF project TAC. Attend annual TAC meeting.					
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))					
NA					

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: Mid-America Freight Coalition (MAFC) Phase 3

FUNDING SOURCE: ☒ FHWA ☐ OTHER (PLEASE EXPLAIN)

TPF NO.	TPF-5(396)	MDOT START DATE	2/1/2019
PROJECT NO.		MDOT COMPLETION DATE (Original)	9/30/2021
OR NO.	OR19-206	COMPLETION DATE (Revised)	
MDOT TECHNICAL CONTACT	Larry Karnes 517-335-4604 KarnesL@michigan.gov		
LEAD AGENCY:	Wisconsin Department of Transportation		
PROJECT MANAGER	Ethan Severson ethanp.severson@dot.wi.gov		
CONTRACTOR			

BUDGET STATUS					
FY 2019 Budget			Total Budget		
FY FUNDS	(Original)	\$37,000.00	TOTAL COST	(Original)	\$111,000.00
	(Revised)			(Revised)	
TOTAL FY 2019 EXPENDITURES		\$37,000.00	Total Committed Funds Available		\$74,000.00

PARTICIPATING STATES	
ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.	
IA,IL,IN,KS,KY,MI,MN,MO,OH,WI	

PURPOSE AND SCOPE	
<p>The Wisconsin Department of Transportation (WisDOT) is leading a pooled fund that will:</p> <ul style="list-style-type: none"> • Produce freight-related research results • Improve cross-state freight-related coordination and facility development • Increase awareness of the importance of freight transportation for the nation's economy 	

Ultimately, the results of the Mid-America Freight Coalition (MAFC) activities will support and develop the economic well-being of the industries, businesses, farms, and the people of the ten-state region by keeping their products flowing to markets safely, reliably, and efficiently. Participation in this pooled fund presents an opportunity for agencies to support research on freight and economic development issues specific to the needs of transportation agencies, advance regional freight-related coordination, and ultimately allow for the quick implementation of research and development efforts.

Products of previous iterations of the MAFC pooled fund have included:

- High-quality research reports
Recently published reports from TPF-5(293) have included an examination of the impact of Upper Mississippi River lock and dam shutdowns on state highway infrastructure, and the development of a potential regional regulatory approach to truck platooning
- Annual freight conferences attended by representatives of the ten states
Recent conferences have run concurrent with the Ohio Conference on Freight and the MAASTO Annual Meeting
- Educational seminars and training sessions conducted for state transportation officers
- Support to MAASTO state Freight Advisory Committees
- Direct support to MAASTO Planning and Motor Carrier Committees

Using the MAFC as a foundation, partner agencies will be able to take advantage of a wide range of expertise in truck, rail, waterway, air, and multimodal freight planning, research, management, and operations to assess and answer their regional freight research needs

The MAFC actively engages and supports freight-related activities of the MAASTO states through research projects and reports, the MAFC annual freight conference and outreach efforts, web applications, and personal communications. While specific research topics remain to be approved by the MAASTO Board of Directors (with one exception), objectives of a third iteration of MAFC efforts will generally:

- Define, conduct, and publish critical freight and economic research in coordination with the states that will support and improve freight-related facility development efforts and the related outcomes
- Identify, evaluate, and share information, technologies, and best practices between state agencies to increase awareness and speed of implementation of best practices and increase the effectiveness of freight development initiatives. This will include a "Truck Parking Information Management System" data warehousing and performance metrics development effort that was approved, but not contracted, during TPF-5(293)
- Increase the awareness and utilization of the linkages between freight transportation investments and local, regional, and national economic development
- Continue to advocate and support a regional approach to freight planning, policy and operations
- Keep abreast of industry and commodity trends and incorporate this information into MAFC communications and efforts; strive to be a clearinghouse for freight information and research

- Maintain the MAFC website as an up-to-date resource, a source of innovative freight development ideas, and as an information-sharing hub
- Actively contribute to the development of freight policy and national freight research direction through the AASHTO and the TRB

FISCAL YEAR 2019 ACCOMPLISHMENTS

Major accomplishments include the following:

1. Completed Identification of Urban Truck Parking Locations in the MAASTO region
2. Completed Quantification of the Value of Multimodal Freight Investments
3. Completed Assessment of Multimodal Bottlenecks in the MAASTO region
4. Completed Freight Data Inventory and Training
5. Completed Truck Parking Information System (TPIMS) Performance Metrics and Data Warehouse Preparation

In addition, the MAFC held several conference calls with its members as needed and completed planning for and held its Annual Meeting in Indianapolis August 13-14, 2019.

FISCAL YEAR 2020 PROPOSED ACTIVITIES

Proposed research by the MAFC for fiscal year 2020 includes the following:

1. Review and Assessment of Rail Waybill Data
2. Develop Regional Freight Plan
3. Evaluation of Air Freight Operations in the MAASTO states
4. Region-Wide Freight Survey
5. Benefits of Weigh Station Investments on Pavement Longevity and Expense
6. Update of Freight Plan Alignment Project
7. System Failure with Automated Vehicles and Truck Platooning: What is Safe?
8. Literature Review and Bibliography of Ports and Waterway Studies

The above prioritized research activities were approved by the MAASTO Board of Directors. In addition, the MAFC will hold conference calls with its members as needed and plan for its 2020 Annual Meeting.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))

An additional project scheduled for completion in fiscal year 2019, the MAASTO Regional Truck Parking Inventory—Oversize and Overweight Vehicle Support for MAASTO Standing Committee on Highway Transport and Motor Carrier Committee was cancelled due to delays in acquiring data. No invoices were submitted for development of the report.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION

MAFC and its member states continue to share results of the MAFC research.

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: TRB Core Program Activities FFY 2019 (TRB FY 2020)					
FUNDING SOURCE: <input checked="" type="checkbox"/> FHWA <input type="checkbox"/> OTHER (PLEASE EXPLAIN)					
TPF NO.	TPF-5(397)		MDOT START DATE		10/01/2018
PROJECT NO.	Not applicable		MDOT COMPLETION DATE (Original)		09/30/2019
OR NO.	OR19-202		PROJECT COMPLETION DATE (Revised)		
MDOT TECHNICAL CONTACT	André Clover, 517-636-6053 CloverA@michigan.gov				
LEAD AGENCY:	Federal Highway Administration (FHWA)				
PROJECT MANAGER	Jean Landolt, 202-493-3146 Jean.Landolt@dot.gov				
CONTRACTOR	Not applicable				
BUDGET STATUS					
FY 2019 Budget			Total Budget		
FY FUNDS	(Original)	\$190,026.00	BUDGETED AMT.	(Original)	\$190,026.00
			ACTUAL COST		\$190,026.00
TOTAL FY 2019 EXPENDITURES		\$190,026.00	Total Committed Funds Available		\$0.00
PARTICIPATING STATES					
ABBREVIATE THE PARTICIPATING STATES. IF MDOT IS THE LEAD AGENCY, ALSO LIST THE CONTRIBUTION PERCENTAGE PER STATE.					
AK , AL , CA , CT , DE , GDOT , ID , IN , MDOT SHA , ME , MI , MN , MO , MT , NC , ND , NHDOT , OH , OR , PA , SC , SD , TX , UT , WI , WV					
PURPOSE AND SCOPE					
The Michigan Department of Transportation provides annual financial support for the Transportation Research Board's (TRB's) Core Program technical activities. This support helps to operate TRB annual meetings, the committee structure, state visits by TRB, and the TRB publication program. This pooled fund study permits states to make their contributions to the TRB Core Program instead of sending their contributions to the TRB directly.					
FISCAL YEAR 2019 ACCOMPLISHMENTS					
<ul style="list-style-type: none"> ○ 2019 TRB Annual Meeting. ○ Committee/subcommittee meetings. ○ State field visits. ○ TRB publication Program administration. 					
JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))					
Not applicable.					
SUMMARY OF THE IMPLEMENTATION RECOMMENDATION					
MDOT technical experts have access to all TRB publications to review and share internally as appropriate.					

**RESEARCH ADMINISTRATION
MDOT TRANSPORTATION POOLED FUND STUDY
ANNUAL REPORT - FISCAL YEAR 2019**

STUDY TITLE: National Cooperative Highway Research Program (NCHRP)					
FUNDING SOURCE: <input checked="" type="checkbox"/> FHWA <input type="checkbox"/> OTHER (PLEASE EXPLAIN)					

TPF NO.	TPF-5(419)		MDOT START DATE	10/01/2018	
PROJECT NO.	Not applicable		MDOT COMPLETION DATE (Original)	09/30/2019	
OR NO.	OR19-201		COMPLETION DATE (Revised)		
MDOT TECHNICAL CONTACT	Andre' Clover, 517-636-6053 CloverA@michigan.gov				
LEAD AGENCY:	Federal Highway Administration (FHWA)				
PROJECT MANAGER	Jean Landolt, 202-493-3146 Jean.Landolt@dot.gov				
CONTRACTOR	Not applicable				

BUDGET STATUS						
FY 2019 Budget			Total Budget			
FY FUNDS	(Original)	\$1,200,000.00		BUDGETED AMT.	(Original)	\$1,200,000.00
	(Revised)*	\$1,229,835.00		ACTUAL COST	(Revised)	\$1,229,835.00
TOTAL FY 2019 EXPENDITURES		\$1,229,835.00		Total Committed Funds Available		\$0.00

PARTICIPATING STATES
The NCHRP 5-1/2% total for FY 2019 (50 states plus DC) was \$45,941,640.00

PURPOSE AND SCOPE
Every federal fiscal year, State Departments of Transportation are solicited to contribute 5.5 percent of their State Planning and Research (SP&R) Program federal funds to the National Cooperative Highway Research Program (NCHRP) to ensure its continued successful operation. The NCHRP is a federal program in place to develop and fund national transportation research in acute problem areas that affect highway planning, design, construction, operation, and maintenance nationwide. The NCHRP disseminates information throughout the transportation community and conducts independent research that benefits various transportation agencies throughout the country.

FISCAL YEAR 2019 ACCOMPLISHMENTS
Published Materials: NCHRP reports are often written as guidebooks or manuals. However, supplemental research project material—such as appendixes, describe technical details, information-gathering activities, or survey instruments; glossaries; and bibliographies. These are disseminated online as web-only documents. Published syntheses report on the state of the practice based on literature reviews and surveys of recent activities in critical areas. Other types of published works are Research Results Digests (RRDs); Legal Digests (LRDs); Web-Only searchable documents and Selected Studies in Transportation Law.

JUSTIFICATION(S) FOR REVISION(S) (List the approval date for the revision(s))
None.

SUMMARY OF THE IMPLEMENTATION RECOMMENDATION
Research findings are published in the NCHRP Reports series and the NCHRP Syntheses of Highway Practices series. MDOT technical experts have access to all NCHRP productions and continually review, share, and incorporate NCHRP research findings and recommendations into its business operations as appropriate.

APPENDIX

FISCAL YEAR 2018 REPORT UPDATES

The following update is a change to the MDOT *State Planning and Research Part II Program Fiscal Year 2018 Annual Report*:

Table 1 – 80% Federally Funded Projects (Pg. 5):

- Last year, zero costs were reported for project number 128607, “Connected/Automated Vehicle and Infrastructure Research,” under contract with the University of Michigan (2014-0006). Expenses should have been reported due to a transfer of \$126,864.00 in funds to pay for striping on the US-23 Flex Route. This should also be updated on the project form (Pg. 19).
- Completion of an audit for project number 128652, “Association of Michigan’s Older Adult Crashes with Roadway Features” (Western Michigan University contract 2013-0069 Z10) resulted in an additional FY 2018 payment of \$5,605.38 on this previously closed project.
- FY 2018 Expenditures for project number 203301, “Sponsorship of the TRB Roundtable on Preparing for Automated Vehicles and Shared Mobility Services,” should read \$0.00 because the \$25,000.00 payment noted did not occur until FY 2019. This should also be updated on the project form (Pg. 83).

Table 3 – 100% Federally Funded Projects (Pg. 9):

- Reported expenditures of \$513,000.00 for project SPR1684(187) titled, “AASHTO 3.01 – Construction/Materials Module Enhancement/Implementation and Staff Training,” should read \$0.00 because the funds were paid in FY 2019. This should also be updated on the project form (Pg. 89).